# PETROLEUM RESOURCE ASSESSMENT OF THE EAGLE PLAIN, YUKON TERRITORY, CANADA

National Energy Board
for Energy Resources Branch

November 2000
Whitehorse, Yukon

Yukon
Economic Development

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# FOREWORD

The original report of November 1994 was reprinted in 1998 and 1999. This version has been updated to reflect current stratigraphic nomenclature.

***To the CD-ROM version (March 1999)***

The Oil and Gas Resources Branch, Department of Economic Development, Government of Yukon are pleased to provide a digital copy of the *Petroleum Resource Assessment of the Eagle Plain, Yukon Territory, Canada*. The original report of November 1994 was reprinted in an enhanced format in March 1998. This digital version is a copy of the March 1998 reprint with minor corrections to the diagrams.

The Oil and Gas Resources Branch was previously known as the Energy Resources Branch. The text of this document refers to the Energy Resources Branch.

On November 19, 1998, the Government of Canada transferred to the Government of Yukon the administrative legislative powers and responsibilities of managing onshore oil and gas resources. Yukon oil and gas resources are now governed under the Yukon *Oil and Gas Act*.

***To the original report (November 1994)***

The Government of Canada and the Government of Yukon have reached an agreement to transfer to Yukon the administrative legislative powers and responsibilities of managing onshore oil and gas resources. In the interim, officials of Canada involved in the administration of federal oil and gas legislation are cooperating and consulting with Yukon to facilitate implementing the Accord.

A study of the petroleum resources of the Yukon part of the Eagle Plain was undertaken by the National Energy Board (NEB) in response to a request from the Yukon Territorial Government. Assessment of petroleum resource potential is important for forming regulatory policies for these resources and for providing a basis for planning and issuing exploration rights.

# EXECUTIVE SUMMARY

The Eagle Plain is an immaturely explored area with proven Cretaceous, Carboniferous and Devonian gas and oil measures. Potential exists for further gas and oil discoveries in these and lower portions of the stratigraphic section.

| | |
|---|---|
| **Basin Age** | Early Paleozoic to Cretaceous; Quaternary cover. |
| **Basin Area in Yukon** | 20,608 km² (8,050 sq. miles). |
| **Depth to Target Zones** | Middle Devonian targets: 1,000 to 2,000 m (3,300 to 6,400 ft.);<br>Carboniferous targets: 800 to 1,500 m (2,600 to 5,000 ft.);<br>Lower Cretaceous targets: 600 to 1,000 m (1,960 to 3,325 ft.). |
| **Maximum Basin Thickness** | 5,800 m. |
| **Hydrocarbon Shows** | Surface: none. Subsurface: Gas: In several wells, from Silurian-Ordovician Bouvette Formation to Upper Cretaceous Fishing Branch Formation. Oil: In several wells, from Carboniferous Chance Member to Permian Jungle Creek Formation. |
| **First Discovery** | Western Minerals Chance Y.T. No. 1 M-08 (Rig Release 25-May-60; Fishing Branch Formation gas, Chance Member gas and oil, Canoe River Member gas and oil, Tuttle Formation gas). |
| **Last Discovery** | Socony Mobil Western Minerals Birch B-34 (Rig release 08-June-65; Chance Member gas, Tuttle Formation gas). |
| **Discovered Resources** | Gas: 2,376 $10^6 m^3$ (83.7 Bcf) Oil: 1.8 $10^4 m^3$ (11.1 MMbbls). |
| **Production** | No production to date. |
| **Potential Resources (Study Area Totals)** | Gas: Mean 28,478 $10^6 m^3$ (1,005.7 Bcf) @ 45% probability.<br>Oil: Mean 4.5 $10^6 m^3$ (28.2 MMBbls) @45% probability. |
| **Basin Type** | Paleozoic to Lower Mesozoic: shallow marine shelf; Mesozoic to Recent: intermontane compressional. |
| **Depositional Setting** | Shallow water carbonate and clastic shelf. |
| **Potential Reservoirs** | Carbonate reefal mounds and facies fronts; fractured carbonates; unconformity traps and discontinuous marine clastic lenses. |
| **Regional Structure** | Long wavelength folds at surface; detachments with thrust-folds within deeper strata; contraction and minor relaxation faulting. |
| **Seals** | Cretaceous Targets: shale of the Whitestone River Formation.<br>Permian Targets: Cretaceous shale of the Whitestone River Formation.<br>Carboniferous Targets: Lower Carboniferous Alder Member limestone or Upper Carboniferous Blackie Formation shale.<br>Devonian Targets: Lower Carboniferous Ford Lake Formation shale, Upper Devonian Imperial and Canol formations shale or Middle Devonian carbonate.<br>Silurian-Ordovician Targets: Road River Formation shale or Bouvette Group carbonates. |
| **Source Rocks** | Cretaceous shale; Carboniferous shale; Devonian shale. |
| **Depth to Oil/Gas Window** | 1,900 to 3,100 m. |
| **Wells in Study Area** | 32 (2 gas wells, 2 gas and oil wells, 1 oil well, 27 dry) |
| **Released Seismic Coverage** | 2D: 9,952 line kilometres (6,170 miles), 8% post 1975.<br>3D: 0 line kilometres, 0% post 1975. |
| **Pipelines** | None. |

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# INTRODUCTION

The objective of this study was to investigate the petroleum resource potential and endowment of the Eagle Plain (Figure 1). The study area is located in the north-central portion of the Yukon between latitudes 65° and 68° N and longitudes 135° and 140° W, and covers an area of approximately 20,608 km² or 8,050 sq. miles (Figure 2). The Arctic Circle bisects the basin. Physiographic features of the study area are the Eagle Plain bounded by surrounding mountain ranges: including the Keele, Nahoni and Taiga ranges of the Ogilvie Mountains, and the Richardson Mountains.

## ACKNOWLEDGEMENTS

The National Energy Board would like to acknowledge the previous work done on this basin by staff at the Institute of Sedimentary & Petroleum Geology in Calgary. Key papers used in preparation of this report were done by J. Dixon, A.P. Hamblin, A.W. Norris, and D.C. Pugh and are included in the references. Thanks are also given to T. Bird, J. Dixon, A.P. Hamblin, D.W. Morrow, and L. Lane for their review and comments.

## METHODOLOGY

The analysis of the hydrocarbon endowment of the Eagle Plain study area began with documentating and synthesizing the regional geological setting as it relates to the basin evolution, geometry, sedimentation history, geochemistry, structural history and hydrocarbon occurrences (shows and discoveries) within the study area. Current literature on the geology and resources discovered in the basin are listed in the references. The results of this study were synthesized into a series of geologic illustrations and maps that show: 1) the geologic settings of the discoveries and the parameters that control the discovered resources; 2) schematic cross-sections which describe and illustrate play complexity; and 3) play maps showing areas with the potential for discoveries similar to those already made and conceptual discoveries that should be present based on sound geological analysis. Within this framework, models for hydrocarbon entrapment within the study area were developed.

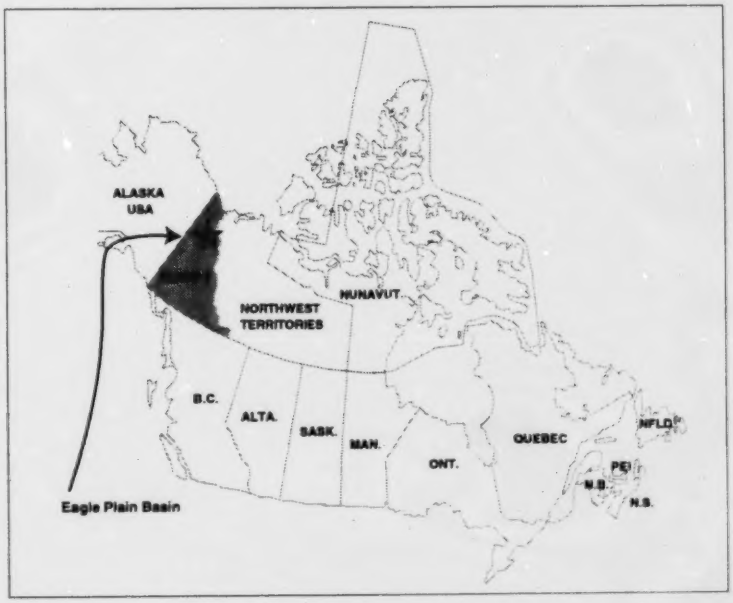



***Figure 1.*** *Eagle Plain location map.*

The discovered resource and show information is summarized in Table 1 (page 10). These hydrocarbon occurences clearly demonstrate that a varied geographic and geologic distribution exists within the study area and points to a wide range of potential oil and gas reservoirs.

Geoscientific analysis was followed by systematic statistical analysis using a resource assessment methodology developed by the NEB. A description of the methodology was included in the NEB's *Natural Gas Resource Assessment, Northeast British Columbia* released as a working paper in January 1994. This methodology uses a series of developed

in-house templates, created in the spreadsheet software package "Excel 4.0®" by Microsoft Corporation, combined with Pallisade Corporation's "@RISK®" add-in set of programs. @RISK links directly to Excel and adds risk analysis and modelling capabilities to the Excel spreadsheet models.

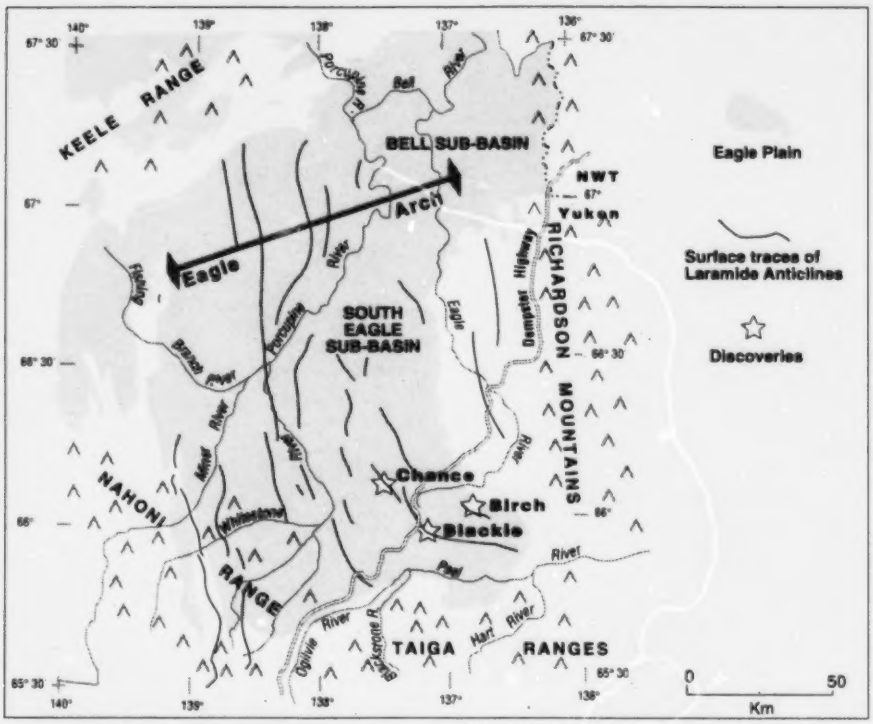



***Figure 2.*** *Physiographic features of Eagle Plain.*

## UNITS/ABBREVIATIONS

$10^6m^3$ - million cubic meters
ac-ft - acre feet
AOF - absolute open flow
Bbls - barrels
Bcf - billion cubic feet
BOE - barrels of oil equivalent
d - day
ft - feet
ft kb - feet below Kelly (the floor of the drill platform)
GIP - gas in place
GOR - gas/oil ratio
Ha - hectares
IMG - marketable gas
km - kilometres
m - metres
md - millidarcies
mi - miles
mKb - metres below Kelly (the floor of the drill platform)
MMbbls - million barrels
MMcf - million cubic feet
psi - pounds per square inch
Tcf - trillion cubic feet

# REGIONAL GEOLOGICAL SETTING

The study area includes the present day physiographic elements of Eagle Plain and its surrounding mountain ranges (Figure 2). The Eagle Plain area lies within an intermontane compressional basin with a maximum sediment thickness of 5,800 m. Outcrops of Mesozoic sediment in the surrounding mountain ranges outlines the basin. Recent alluvium covers much of the region's surface. The present Eagle Plain geomorphology consists of low rolling hills with elevations varying between 400 and 800 m. The southern plains are lightly forested with the amount of forestation thinning to the north. Tundra conditions exist in both the northern areas and at higher elevations in the southern areas. Year-round access to the basin is via the Dempster Highway.

## STRATIGRAPHY AND DEPOSITIONAL SETTING

The Eagle Plain area underwent continuous subsidence and deposition as part of the western miogeosyncline during Cambrian to Carboniferous times. After the Carboniferous, there was a long period of emergence, with the exception of clastic deposition during the Permian. This emergence is recognized by the absence of Triassic and Jurassic sediments in the region. Deposition returned in the Lower Cretaceous, followed by more erosion before Upper Cretaceous deposition.

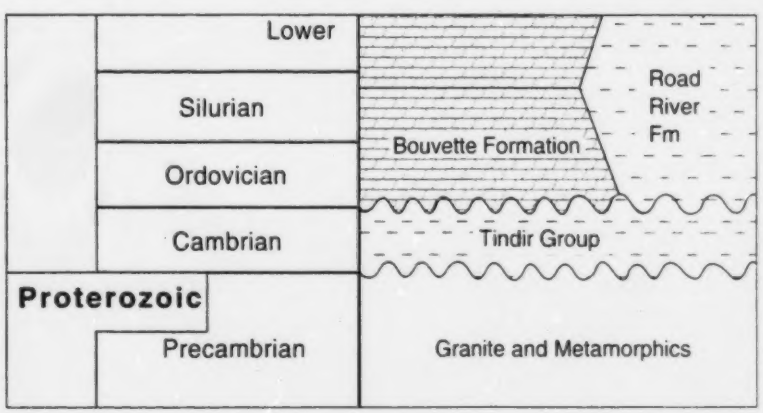
The Eagle Plain area offers a setting of stratigraphic conditions suitable for the sourcing, migration and entrapment of hydrocarbons. An understanding of the stratigraphy and depositional setting is therefore important for analyzing the discovered hydrocarbon accumulations and for predicting possible conceptual accumulations. The age, name and lithology of potential reservoir and source rock horizons found in the study area are outlined in Figure 3, and in the following written summary.

### PRECAMBRIAN

Underlying the Phanerozoic cover of the study area and forming the effective economic basement is a mixture of metasediments of Precambrian, likely Helikian age. Metasediments include shale, dolomite, argillite and orthoquartzite (a silica-cemented quartz sandstone). No wells in the area have been drilled into the Precambrian. However, other wells, mainly on the Peel Plateau have encountered these metasediments.

### CAMBRIAN

Cambrian sedimentary strata have been encountered in four wells in the Eagle Plain, and consist of mainly shale and evaporite. They are not considered to have any potential reservoir units. Total thickness of the sediments is estimated to be 400 to 500 m. The Cambrain sediments are called the Tindir Group, and are correlative to the Mount Clark, Mount Cap and Saline River formations of the Mackenzie and Liard areas according to Pugh (1983).



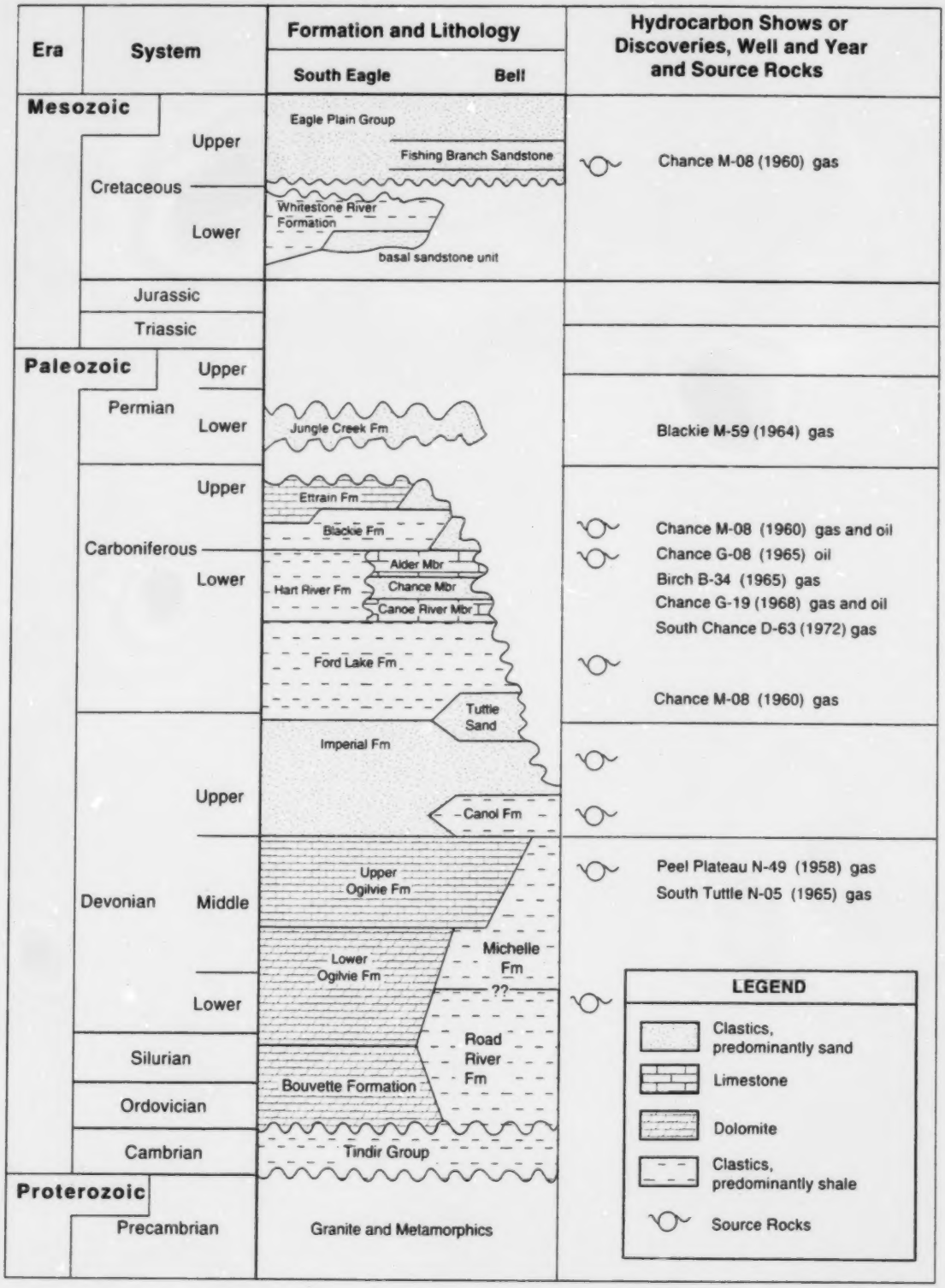



*Figure 3. Stratigraphic column for the Eagle Plain study area.*

### CAMBRO-SILURIAN

A thick Cambrian to Silurian carbonate shelf facies, called the Bouvette Formation, overlies the Cambrian shale in this area. The Lower Paleozoic dolomite grades eastward into thick basinal shale of the Road River Formation in the Richardson Trough. Here, the Bouvette consists of a thin, upper, cherty limestone and dolomite unit that caps a thicker section of light-coloured, medium to coarsely crystalline dolomite, grey-coloured microcrystalline dolomite and interbedded orthoquartzite and shale. This succession reaches an average thickness of 1,000 m.

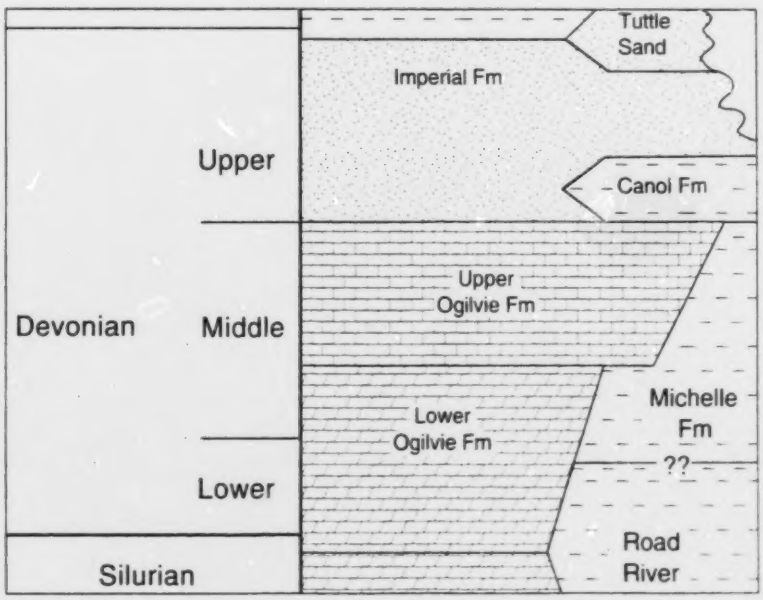
In the northwestern and southeastern portions of the Eagle Plain, the Bouvette Formation is unconformably overlain by the Road River Formation clastics. While these clastics were being deposited, shale deposition continued in the Richardson Trough. Traps may form in the Bouvette where porous dolomite pinches out against tight limestone or where the entire unit pinches out against the carbonate-shale facies change.

### DEVONIAN

Lower and Middle Devonian strata are represented by the Ogilvie formation. The Lower Ogilvie consists of light-brown to dark-brown and buff-coloured, finely crystalline to sucrosic dolomite with vuggy and intercrystalline porosity. The Upper Ogilvie consists of medium-brown to grey, fine-grained, thin-bedded to massive limestones with beds of coarse-grained encrinite (a crinoidal-rich coquina bed).

The Ogilvie formation was deposited as a carbonate bank within this area and passes into the basinal shale of the Upper Road River Formation in the Richardson Trough. This pinchout occurs near the South Eagle and Bell Sub-basins at the Eagle Arch. The lower dolomite occupies a back-bank position in this basin and does not extend out to the carbonate-shale facies change. It is described as dark-grey to black shale with minor thin interbeds of limestone, overlain by interbedded shale and limestone and an upper section of interbedded shale and black chert.

A major change in the regional tectonic setting and sedimentation style occurred at the end of the Lower Paleozoic. Carbonate-dominated Lower Paleozoic units were capped by a thick sequence of Upper Paleozoic clastic-dominated units consisting of a mixture of clastics and carbonate. The Upper Paleozoic facies belts trend north-south on the west side of the plain and east-west on the south end of the plain. Sediments were sourced from the north and northeast.

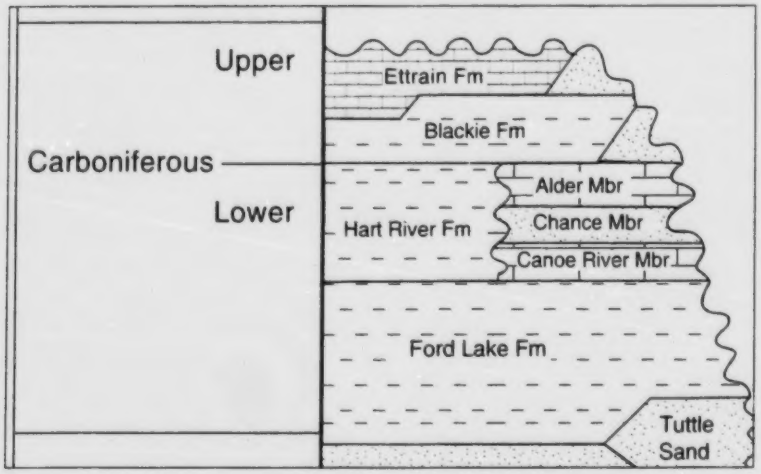



Upper Devonian deposition began with an influx of sandy shales or siltstone of the Imperial Formation. The Imperial can be up to 1,900 m thick. In basinal areas, the initial deposition consisted of black, very thin-bedded, cherty shale of the Canol Formation, which may be 125 m thick. The Imperial was replaced in part by a thick sequence of coarse-grained clastics called the Tuttle Formation. The Tuttle reaches a maximum thickness of 1,421 m in the O-22

well. Tuttle deposition did not extend to the west side of the area, where Imperial clastics continued to accumulate. The Tuttle consists of vari-coloured chert conglomerate and very poorly sorted quartz and chert sandstone, and grey and brown shales. Upper Devonian deposition closed shortly after deposition of the shale dominated Ford Lake Formation started. The Ford Lake consists of dark-grey to black shales, siliceous siltstone and sandstones and orthoquartzite. The Ford Lake reaches a maximum thickness of 975 m.

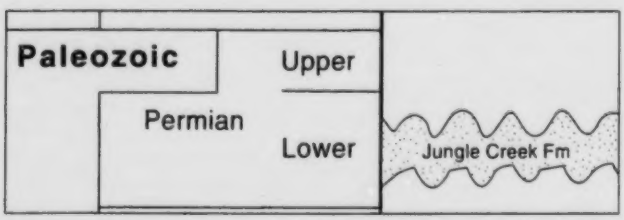
### CARBONIFEROUS

Ford Lake deposition continued well into the Lower Carboniferous, before being overlain by shale and carbonate of the Hart River Formation. Shale was deposited on the west side of Eagle Plain, while laminated silty micritic limestone, dolomite and chert were deposited on the east side. This carbonate unit is informally called the Canoe River Member, and may be up to 480 m thick. The carbonates were conformably overlain by sand-dominated sediments, while shale deposition continued in the west. This sandstone unit is called the Chance Member and consists of conglomeratic sandstone, medium- to coarse-grained sandstone and calcareous shale. Maximum thickness intersected in drilling is 310 m. The Chance Member is conformably overlain by a repetition of the carbonates, while shale deposition continued in the west. This second carbonate unit is informally called the Alder Member.




Upper Carboniferous sediments are represented by the shale of the Blackie Formation. The Blackie may be almost 700 m thick and consists of black bituminous shale in the lower 294 m and brown-grey argillaceous or calcareous siltstone in the upper portion. The Blackie may have some marine sandstone deposited towards the east. The Blackie is conformably overlain by up to 732 m of limestone belonging to the Ettrain Formation. The Ettrain consists of light-grey skeletal limestone with grey chert lenses or micritic skeletal limestone with some coarser units of skeletal limestone. The Ettrain also contains some marine sandstone eastward.

### PERMIAN




The only preserved Permian sediments belong to the Jungle Creek Formation, which has a maximum thickness of 719 m in the N-53 well. The Jungle Creek consists of skeletal conglomeratic limestone, micritic limestone, calcareous sandstone and siltstone. Locally, it consists of a calcareous chert pebble conglomerate.

### TRIASSIC

No Triassic sediments are preserved in the study area.

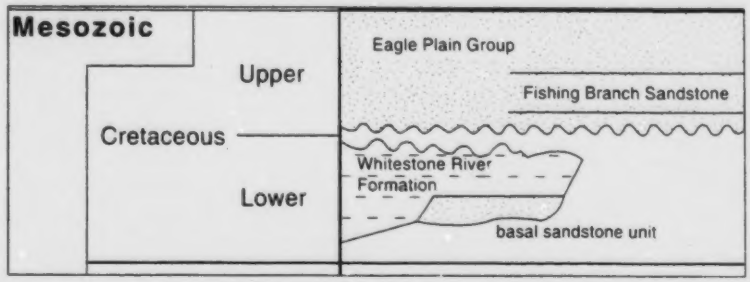
### JURASSIC

No Jurassic sediments are preserved in the study area.

### CRETACEOUS

Lower Cretaceous consist of a thick sequence of marine siltstone, shale and sandstone. The Whitestone River Formation, which has a maximum thickness of 1,500 m, consists of shale interbedded with very fine-grained sandstone and siltstone. There is a basal sandstone unit which covers most of the study area.

Upper Cretaceous strata unconformably overly the Whitestone River Formation and is called the Eagle Plain Group. The Eagle Plain Group can be up to 1,680 m in thickness and consists mainly of shale interbedded with fine- to coarse-grained, locally pebbly, sandstone and siltstone. One of the formations within the Eagle Plain Group is the Fishing Branch Sandstone, which was formerly called the Blackie Sand. It consists of about 820 m of shales and sandstone.




### TERTIARY TO RECENT

Altough there is evidence of glaciation (mainly glacial erratics) on the east and west sides of the basin, there is no evidence of glacial deposits in the basin. These systems are marked only by deposits of fluvial sand and gravel in the major river valleys.

## STRUCTURAL GEOLOGY

The northern Yukon area was essentially a stable cratonic region during the Lower Paleozoic. Shallow-water carbonate of the Lower Paleozoic is bounded on the east by a major carbonate to shale facies change into the Richardson Trough.

Upper Paleozoic facies transitions trended north-south along the west side of the craton. However, an east-west trend developed later as the Aklavik Arch formed to the north. A series of tectonic pulses during the Upper Devonian and Permian deposited a number of clastic wedges. These shallow water clastics and carbonates were sourced from the northeast and are bounded on the southwest by a major facies change to basinal shale. Thick Cretaceous sediments indicate that the Eagle Plain was a depositional basin associated with Cordilleran deformation.

The Eagle Plain is a structural depression surrounded by exposed Paleozoic rocks, brought to the surface by complex normal and thrust faulting. Before Mesozoic deposition, the east-west trending Eagle Arch formed, deforming the Paleozoic section into northern and southern sub-basins. The two sub-basins are called the Bell Sub-basin in the north and the South Eagle Sub-basin in the south.

In the South Eagle Sub-basin, the Upper Paleozoic clastics and carbonates subcrop against the pre-Cretaceous unconformity. During the Laramide Orogeny, linear anticlines and synclines trending approximately north-south developed and extend for hundreds of kilometres. These anticlines affect the entire stratigraphic section and have created numerous potential traps in the Upper Paleozoic section. All of the currently discovered hydrocarbons are found in the South Eagle Sub-basin.

In the Bell Sub-basin, similar Laramide anticlinal structures have formed. However, Upper Paleozoic reservoir units were removed by pre-Cretaceous erosion. Potential for the types of traps tested in the South Eagle Sub-basin is minimal for the Bell Sub-basin. This area does have the potential for Cretaceous clastic reservoirs in triangle zone type closures formed by thrust faulting.

## REGIONAL GEOCHEMISTRY

Source rocks have been identified in a number of horizons from the Lower Paleozoic to the Upper Mesozoic. However, they have not all been been properly analysed. The Lower Devonian Michelle Formation (uppermost Road River shale) are the oldest. They average a total organic content (TOC) of between 1 and 2% but some samples go as high as 9.5%, containing mostly Type III kerogens and are thought to be overmature. The Upper Devonian Canol Formation shale, containing Type II and III kerogens, have a TOC of up to 9%, and testing indicates it is are overmature for oil. The Lower Carboniferous Ford Lake Formation shale contains Type II and III kerogens and has a TOC of up to 4%. It is considered to be mature for oil generation. The Upper Carboniferous Blackie Formation shale and organic-rich Ettrain carbonate contain Type II and III kerogens and have a TOC of up to 5%. These formations are marginally mature for oil. The youngest potential source rock is the Cretaceous Whitestone River Formation which also contains Type II and III kerogens and is marginally mature. There may also be some minor source rock potential in the Upper Devonian Imperial shale and in the Lower Permian Jungle Creek Formation.

The depth to the oil window is quite variable in this area. Based on work done by Link & Bustin (1989), in the outcrops of the surrounding mountains, sediments are in the oil window at near-surface conditions. In the Eagle Plain, the depth to the oil window varies from approximately 1,900 m (6,250 ft.) to approximately 3,100 m (10,200 ft.) in the area of the Whitefish J-70 well.

# PETROLEUM GEOLOGY

## EXPLORATION HISTORY

Surface exploration commenced in the mid to late 1950s in this region of the Yukon. The first well drilled was the Peel Plateau Eagle Plain YT No.1 N-49 well (classified as dry and abandoned) with a rig release date of July 1958. The second well, and first discovery, was drilled by Western Minerals at Chance YT No. 1 M-08 with a rig release date of May 1960. This well flowed gas, at a maximum rate of 283 $10^3m^3$ (10 MMcf/d), with 1.1 $m^3$ (6.5 barrels) of oil recovered from the Chance Member of the Carboniferous Hart River Formation. Both of these wells were drilled on Laramide anticlinal structures. Since then, an additional 28 wells have been drilled resulting in further discoveries at the Birch B-34 and Blackie M-59 wells. The most recent wells were drilled in 1985. However, the last discovery was made at Birch in 1965. The deepest well was the Western Minerals North Hope YT N-53, which was drilled and completed in 1970. This well encountered Precambrian sedimentary strata at a total depth of 4,280 m (14,043 ft.). Hydrocarbons have been found and tested in nine separate zones. Additionally, there were two gas shows at deeper levels. The deepest zones penetrated in each of the wells is shown on the accompanying penetration map (Figure 4).

It should be noted on the penetration map, most of the wells drilled to date have only penetrated the shallower horizons, down to the Upper Devonian. Only six wells have penetrated the deeper carbonate horizons of the Ogilvie or Bouvette formations. Most of the large hydrocarbon deposit potential is considered to be in these carbonates.

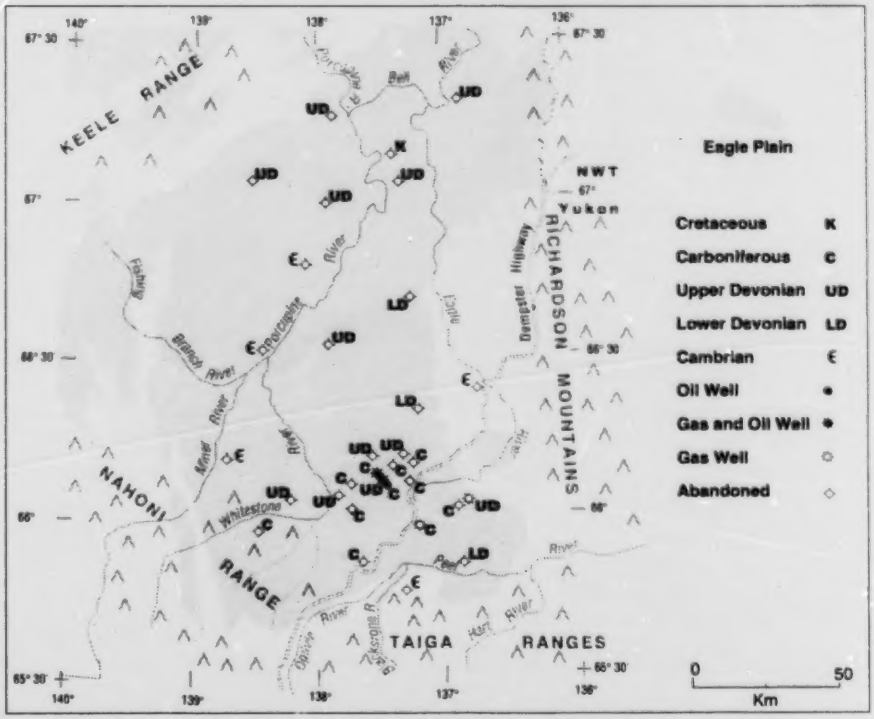



***Figure 4.*** *Well penetration map.*

## DISCOVERED RESOURCES

The NEB released to the public the discovered resources of the Eagle Plain in 1993. The discovered resources and significant shows are given in Table 1. A map of the wells is shown for reference in Figure 5.

***Table 1.*** *Current shows and estimates of discovered resources.*

| Location and Zone — OIL (MMbbls) | Recovery, m (feet) | Estimated Resource, $10^6m^3$ |
|---|---|---|
| Chance D-22 Fishing Branch | oil cut mud | 0 |
| Birch B-34 Jungle Cr. | oil cut mud | 0 |
| Chance M-08 Chance #1 | 610 m (2,000) oil | 700 (4.44) |
| Chance #2 | 4 bbls oil | 20 (0.12) |
| Chance #3 | 4 bbls oil | 0 |
| Canoe R. #2 | 290 m (1,000) oil | 7.3 (0.05) |
| Chance G-08 Chance #1A | 360 m (1,180) oil | 770 (4.87) |
| Chance J-19 Chance #3 | 500 m (1,640) oil | 260 (1.64) |
| Canoe | oil cut mud | 0 |
| E. Chance C-18 Canoe | 37 m (120) cond. | 0 |
| W. Parkin D-51 Canoe | 91 m (300) oil | 0 |
| | | **Total Oil: 1,757.3 (11.05)** |
| **Location and Zone — GAS** | **Recovery, $m^3/d$ (mcf/d)** | **Estimated Resource, $10^6m^3$ (Bcf)** |
| Chance G-08 Fishing Branch | 93,447 (3,300) | 150 (5.0) |
| Chance #1A | gas too small to measure | 0 |
| Chance M-08 Fishing Branch | 22,994 (812) | incl. |
| Chance #1 | 283,174 (10,000) | 770 (27.2) |
| Chance #2 | 14,159 (500) | 212 (7.5) |
| Chance #3 | 14,159 (500) | 212 (7.5) |
| Canoe R. #2 | 283,000 (10,000) | 2.8 (0.1) |
| Tuttle | 226,539 (8,000) | 57 (2.0) |
| W. Parkin C-33 Fishing Branch | 7,929 (280) | 0 |
| Canoe | gas too small to measure | 0 |
| W. Parkin D-51 Fishing Branch | gas too small to measure | 0 |
| Canoe | gas too small to measure | 0 |
| N. Parkin D-61 Fishing Branch | gas cut water | 0 |
| Whitefish J-70 Fishing Branch | gas cut water | 0 |
| W. Parkin D-54 Fishing Branch | 1,004 (36) | 0 |
| Canoe | gas cut water | 0 |
| Chance D-22 Fishing Branch | gas cut mud | 0 |
| Blackie M-59 Jungle Cr. | 79,288 (2,800) | 660 (23.3) |
| Canoe | 4,021 (142) | 0 |
| S. Chance D-63 Jungle Cr. | gas cut mud | 0 |
| Birch E-53 Jungle Cr. | gas cut water | 0 |
| Porcupine I-13 Jungle Cr. | 368 (13) | 0 |
| Canoe | 1,444 (51) | 0 |
| Birch B-34 Jungle Cr. | gas too small to measure | 0 |
| Chance | 150,000 (5,500) | 179 (6.3) |
| Tuttle | 200,000 (7,300) | 81 (3.0) |
| E. Chance C-18 Chance | 56,502 (1,600) | 0 |
| Canoe R. | 14,640 (512) | 0 |
| Chance J-19 Canoe R. #1 | 62,690 (2,214) | 52 (1.8) |
| Porcupine K-56 Canoe R. | gas too small to measure | 0 |
| Whitestone N-26 Tuttle | 13,026 (460) | 0 |
| Ellen C-24 Tuttle | gas cut mud | 0 |
| Whitefish I-05 Tuttle | gassy water | 0 |
| Ridge F-48 Tuttle | 1,246 (44) | 0 |
| S. Tuttle N-05 Ogilvie | gas too small to measure | 0 |
| Lower Ogilvie | 28,540 (1,000) | 0 |
| Schaffer O-22 Lower Ogilvie | gas cut mud | 0 |
| Peel Plat. N-49 Ogilvie | gassy mud | 0 |
| N. Hope N-53 Bouvette | gas cut mud | 0 |
| | | **Total Gas: 2,376 (83.7)** |

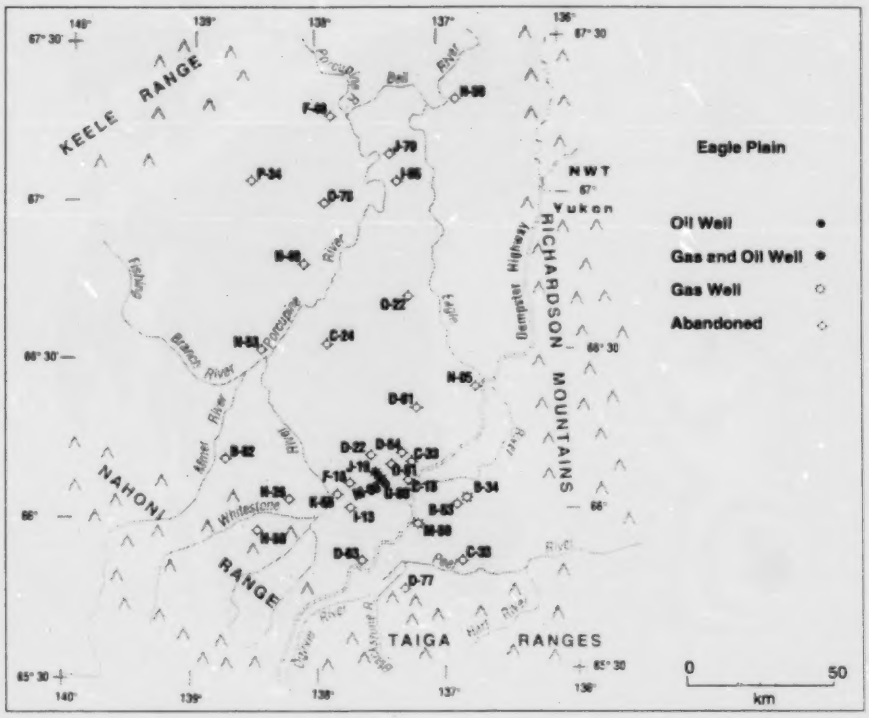



*Figure 5. Well identification map.*

## SEISMIC COVERAGE

### AVAILABLE SEISMIC DATA

All historic seismic coverage has been released to the public and totals 9,952 line kilometres of two-dimensional (2D) surveys. Only 8% of that has been shot since 1975, and no three-dimensional (3D) has been shot to date. The largest regional program was completed by Chevron in 1971. In most cases, gravity and magnetic surveys were conducted concurrently with the seismic. Data is of a reasonable quality but is concentrated in the southern end of the basin in the vicinity of the three existing discoveries. The present seismic coverage for which the NEB has data available is shown on the seismic map (Figure 6).

### SEISMIC EXAMPLES

Parts of four different seismic lines are included at the end of the report (Figures 7 to 10). Each of the lines is described in a general format and each illustrates a different play or plays with the potential for oil or gas.

#### *Chance structure*

The Chance structure is illustrated on Chevron seismic lines 4XA and 32X, which run at angle to each other over the Chance field generally north to south along the strike of Larimide folding (Figure 7, at report end). The statics break in processing due to the different datums of the lines causes a difference in time between Chance M-08 and Chance J-19, whereas the actual depth of the lithologic units vary only slightly in the wells. The polarity is reverse, as can be seen from the correlation of the high velocity

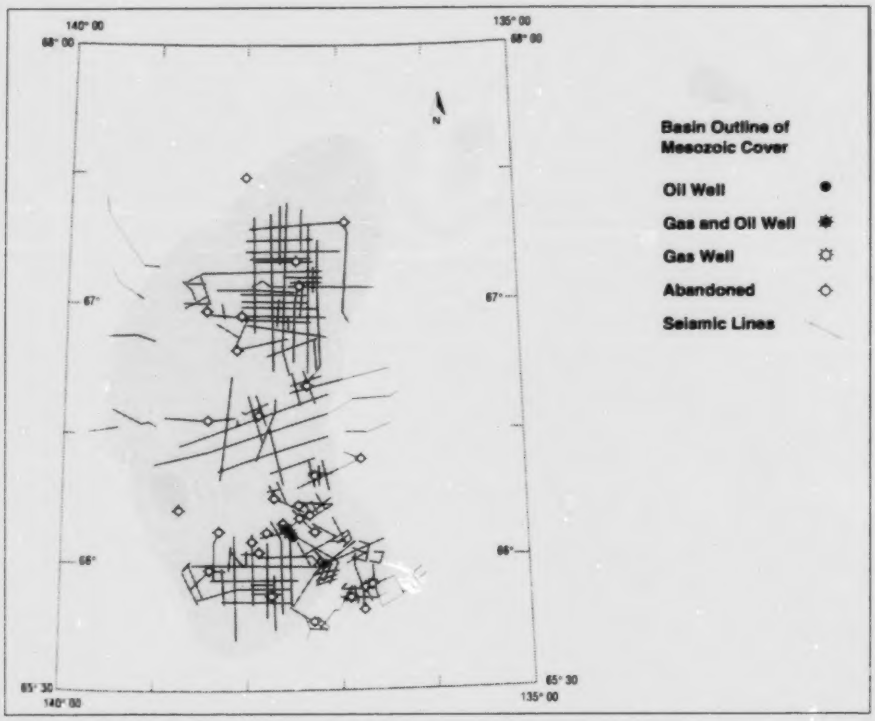



***Figure 6.*** *Seismic map.*

sandstone sequences on the gamma ray log for Chance J-19 and the troughs on corresponding synthetic seismogram.

At the J-19 well, the structure is not conformable with the Lower Paleozoic normal faulting at 2.0 seconds. The folded structure of the Chance field and the increased isopach thickening of the Ford Lake and Imperial formations by 300 m is likely the result of Larimide compression.

The gamma ray log for J-19 shows the seismic correlation of the sand sequences in the Fishing Branch and Hart River formations. The sand in the Fishing Branch, which tested gas in M-08, gives a weak response on the seismic. The basal sand response is also weak at J-19, but shows a higher amplitude as the sand thickens from 60 to 120 m into the low to the northeast. The same is true for the two Chance Member sandstone lobes in the Hart River Formation between 1,234 and 1,372 m, separated by shale and argillaceous limestone. The Chance Member sandstone sequence within the low has several high amplitude events over a 212 m interval, which would likely correspond to similar sandtone-shale sequences similar to those in J-19. The seismic dominant frequency of 40 Hz would give a seismic event for sandstone greater than about 30 m. Tuning of the events was not considered for the weak response at the well. The amplitude increase for the response in the low is more likely explained by a change in lithology.

### PALEOZOIC SUBCROP PLAY

The subcrop edge of the Paleozoic occurs between the Blackie and Chance fields and is evident on Chevron line 4XA which runs north-south (Figure 8, at report end). Subcropping below the sub-Cretaceous unconformity are the Jungle Creek and Ettrain formations and, not shown, but just to the right, the Blackie Formation.

The dipping events and isopach thinning of the Paleozoic formations indicate a depositional slope toward the south. Of particular interest is the isopach thickening of the Hart River and the clinoform-like deposition basinward of the Chance sandstone within this formation.

The maximum thickness of the sequence of high amplitude events is about 250 m and is most likely interbedded sands and shales with some limestone.

The Ogilvie Formation in the lower part of the section shows an anomalous seismic response similar to that for closely spaced normal faults or localized carbonate build-up features. The mapping of this event shows an antiformal structure.

### MIDDLE DEVONIAN CARBONATE EDGE PLAY

The Middle Devonian carbonate to shale transition occurs near the South Eagle Sub-basin-Eagle Arch and is illustrated on Chevron line 15A (Figure 9, at report end). The edge is located on the seismic section where the seismic response below the Canol changes from high amplitude events (corresponding to the impedance contrast of the interbedded shale and carbonate of the Ogilvie Formation) to a quiescent zone corresponding to more uniform lithology.

The sandstones of the Imperial Formation subcrop below the sub-Mesozoic unconformity. These high amplitude reflectors mark the northern edge of the Eagle sub-basin. The seismic response suggests thin sands interbedded with shale and carbonate of the Imperial. The Cretaceous sandstone units from about 670 to 900 m in the Whitefish I-05 well correlate with the series of high amplitude reflectors that continue to the south. There is also a good seismic response for the Lower Cretaceous sandstone including the basal sandstone on the sub-Mesozoic unconformity.

### TRIANGLE ZONE PLAY

At north end of the Bell sub-basin, Larimide thrust compression has resulted in Mesozoic and Cretaceous sediments being uplifted through a series of thrust faults and reverse thrust fault slivers. Chevron line 39X shows the pre-Mesozoic unconformity and the Cretaceous high amplitude events correlated from Whitefish I-05 (Figure 10, at report end).

The lack of well control in the northern area makes an accurate interpretation of the seismic lines difficult. This line is included only to indicate the complexity of the structure and the potential for trapping within the triangle zones. These traps are likely to have enhanced porosity and permeability due to fracturing of the reservoir rocks.

# POTENTIAL RESOURCES

## PETROLEUM PLAYS

The NEB has adopted several descriptive terms in its resource assessments. The following definitions were modified from Reinson et al. (1993). For the purposes of this study a **play** is defined as a family of pools and/or prospects that share a common history of hydrocarbon generation, migration, reservoir development and trap configuration (Energy, Mines and Resources Canada, 1977). A **prospect** is defined as an untested exploration target within a single stratigraphic interval; it may or may not contain hydrocarbons; it is not synonymous with an undiscovered pool. An **established** play is one which is demonstrated to exist by virtue of discovered pools with established reserves or discovered resources. An **immature** play is one which by geological analysis and understanding has been proven to exist but for which there are no commercial discoveries at this time.

Twelve petroleum plays were identified within the study area (7 gas and 5 gas and oil)(Table 2). Seven plays are considered established as they have yielded proven discoveries. The other five have petroleum shows in this basin or in other basins and are considered immature.

NOTE: The estimates of potential resources are based on limited data, especially for the immature plays and for the stratigraphic plays. There is considerable uncertainty involved both in the play analysis and in the play assessment.

***Table 2.*** *Established and immature plays in Eagle Plain.*

| Play | Type | Potential |
|---|---|---|
| *Established Plays* | | |
| Cretaceous Fishing Branch Sandstone | Laramide folds | gas |
| Permian Jungle Creek Sandstone | Laramide folds | gas and oil |
| Carboniferous Chance Sandstone | Laramide folds | gas and oil |
| Carboniferous Chance Sandstone | Structural and stratigraphic | gas and oil |
| Carboniferous Chance Sandstone | Stratigraphic | gas and oil |
| Carboniferous Canoe River Member | Limestone-Stratigraphic | gas and oil |
| Lower Carboniferous Tuttle Sandstone | Stratigraphic | gas |
| *Immature Plays* | | |
| Cretaceous Sandstone | Triangle Zone Structures | gas |
| Upper Carboniferous Ettrain Limestone | Stratigraphic | gas |
| Devonian Ogilvie Carbonate | Stratigraphic | gas |
| Devonian Ogilvie Carbonate | Antiformal Structures | gas |
| Ordovician/Silurian Bouvette | Stratigraphic | gas |

## PLAY SHEETS

A play sheet was prepared for each play on the play list. Each play sheet provides an outline of the geology, a discussion of the discovered resources for that play and a discussion of the undiscovered potential. A table of reservoir parameters is included, based on drilling and test results, as well as a map showing the discovery or show locations, the assigned area of potential, and a schematic cross-section. Following the play sheet is the @Risk data input and output sheets.

Following all the play sheets and data input and output sheets is a table of results for the various plays, a summation of the results and a discussion of the results.

## Cretaceous

## FISHING BRANCH SANDSTONE

# ESTABLISHED GAS PLAY

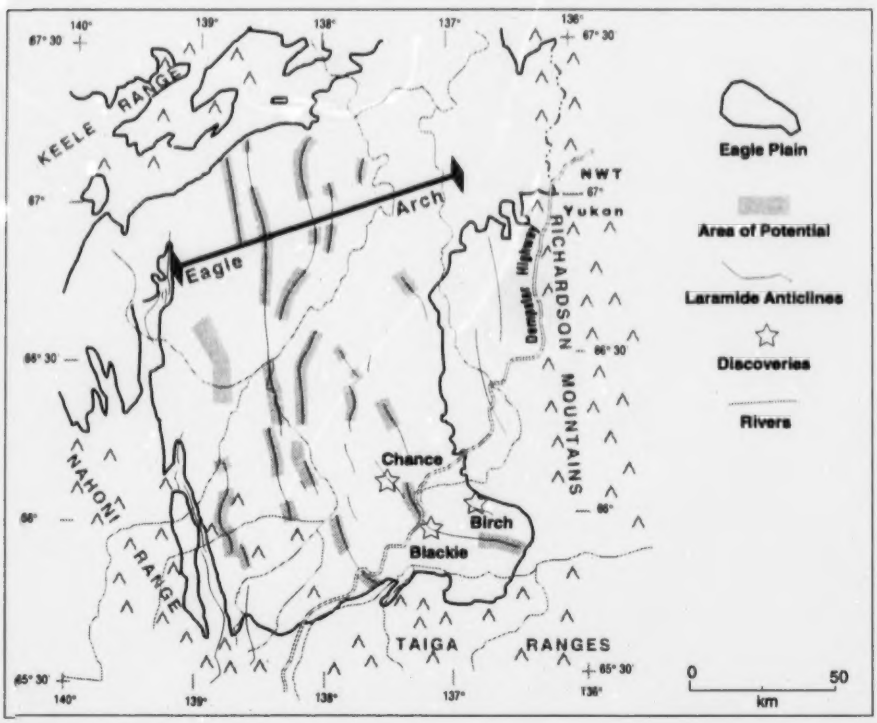
### *Reservoir description*

Fishing Branch Formation reservoirs are produced by the structural drape of sandstone sections over Laramide-aged folds. Linear anticlines trending north-south can be up to 100 km long, may be double plunging, and can represent hundreds of metres of closure. Interbedded reservoir rocks and source rocks are present and structures are visible both on the surface and on seismic sections.

The Fishing Branch sandstone is described as a salt and pepper, fine-grained, medium-sorted, subangular to subrounded, cherty marine sandstone with clear quartz and black and white chert. This unit has up to 50 m of clean sandstone and thins to the northwest.

### *Discovered resources*

So far, only one discovery has been made. In the Chance Field, at wells M-08 and G-08, gas is trapped on top of water. The gas flowed on a drill stem test (DST) at rates up to 23 $10^3$ $m^3/d$ with no recovered oil or condensate.



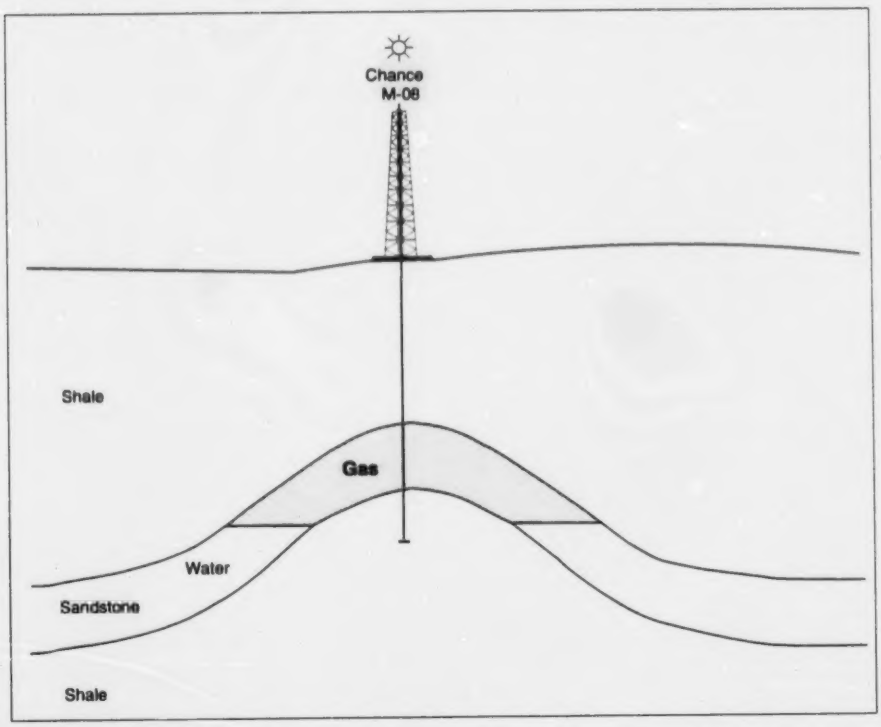
### *Potential resources*

The area of potential resources covers most of the study area, limited only by the distribution of Laramide folding. This is considered to be a gas play, since the source rocks are only marginally mature.

### *Reservoir parameters*

These results are taken from the successful wells in each play. While they may be used as the most likely values on the triangular distribution, that is not necessarily the case.

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| Chance | gas | 458 | 5.0 | 22 | 65 | 47 | 82.5 (2.9) |



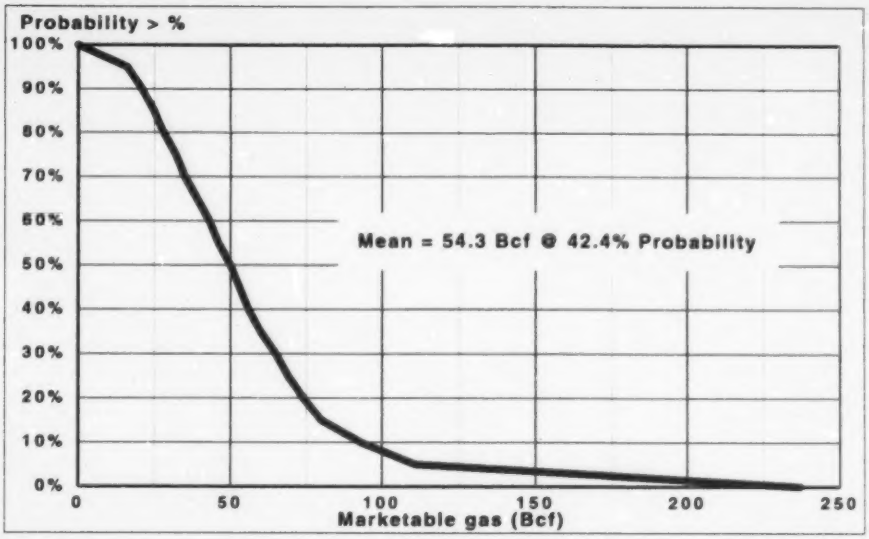
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 3.0000 | 3.3000 | 3.5000 | 3.267 |
| Tested play area (MM acres) | 0.270 | 0.270 | 0.270 | 0.270 |
| Untested play area (MM acres) | 2.730 | 3.030 | 3.230 | 2.997 |
| Fraction of total play area in trap | 0.100 | 0.190 | 0.250 | 0.180 |
| Fraction of untested play area filled (areally) | 0.250 | 0.500 | 0.700 | 0.483 |
| Potential hydrocarbon area (MM acres) | | | | 0.261 |
| Porosity | 0.050 | 0.120 | 0.220 | 0.130 |
| Hydrocarbon saturation | 0.500 | 0.650 | 0.750 | 0.633 |
| Oil recovery factor | 0.100 | 0.150 | 0.200 | 0.150 |
| Gas recovery factor | 0.250 | 0.470 | 0.650 | 0.457 |
| Average net pay (ft.) | 10.0 | 16.0 | 26.0 | 17.3 |
| Probability of hydrocarbons | 0.050 | 0.130 | 0.200 | 0.127 |
| Fraction of pore volume oil bearing | 0.000 | 0.000 | 0.000 | 0.000 |
| Potential oil area (MM acres) | | | | 0.000 |
| Potential gas area (MM acres) | | | | 0.033 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.228 | 0.240 | 0.252 | 0.240 |
| Formation volume factor (FVF) | 1.130 | 1.137 | 1.144 | 1.137 |
| Gas compressibility factor 'Z' | 0.800 | 0.900 | 0.950 | 0.883 |
| Gas volume factor (GVF) | | | | 0.061 |
| Oil in place (bbls/acre-foot) | | | | 561.9 |
| Oil recovery (bbls/acre-foot) | | | | 84.3 |
| Gas in place (MMcf/acre-foot) | | | | 217.0 |
| Raw gas recovery (MMcf/acre-foot) | | | | 99.1 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 93.8 |
| Liquid yield (bbls/MMcf) | 4.000 | 5.100 | 6.400 | 5.2 |
| $H_2S$ content | 0.000 | 0.000 | 0.000 | 0.000 |
| $CO_2$ content | 0.001 | 0.003 | 0.005 | 0.003 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.947 | | |

*Total for play*

| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 0.00 | | 124.21 | 124.21 | | 20.70 | |
| **Recoverable** | 0.00 | 0.00 | 56.72 | 56.72 | 0.29 | 9.75 | 53.71 |
| **Sulphur (MMlt)** | | 0.00 | | | | | |

Oil depth: 2,400 ft.; Gas depth: 2,385 ft.; Gas reservoir temperature: 66°F; gas pressure: 792 psi




**Percentile values**

| | |
|---|---|
| 100% | 0 |
| 95% | 16 |
| 90% | 21 |
| 85% | 25 |
| 80% | 28 |
| 75% | 32 |
| 70% | 35 |
| 65% | 39 |
| 60% | 43 |
| 55% | 46 |
| 50% | 50 |
| 45% | 53 |
| 40% | 56 |
| 35% | 60 |
| 30% | 65 |
| 25% | 69 |
| 20% | 74 |
| 15% | 80 |
| 10% | 93 |
| 5% | 111 |
| 0% | 237 |

Permian

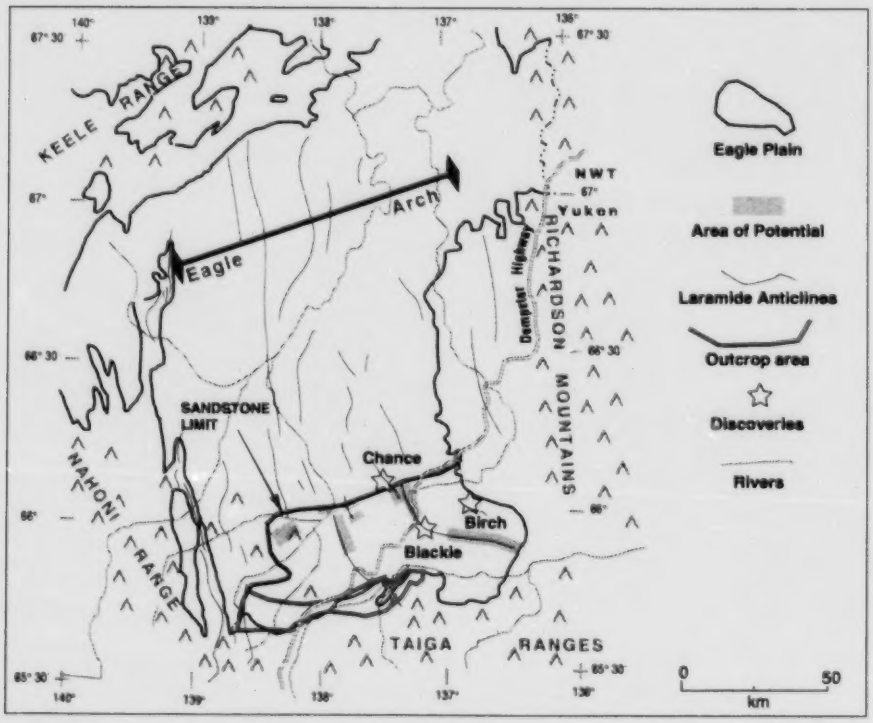
# JUNGLE CREEK SANDSTONE

## ESTABLISHED GAS AND OIL PLAY

### *Reservoir description*

Jungle Creek Sandstone reservoirs are found in closures that have been formed by Laramide-aged anticlines. The Jungle Creek Formation is subcropped by the pre-Cretaceous unconformity. The structural anomaly is observed on the surface and on seismic sections.

The Jungle Creek sandstone is described as having a variable lithology, including skeletal, micritic and spicular limestone, calcareous sandstone, chert pebble conglomerate, calcareous shale, siliceous mudstone and siltstone. The unit can have up to 166 m of clean sandstone, but thins to the south and subcrops to the north.



### *Discovered resources*

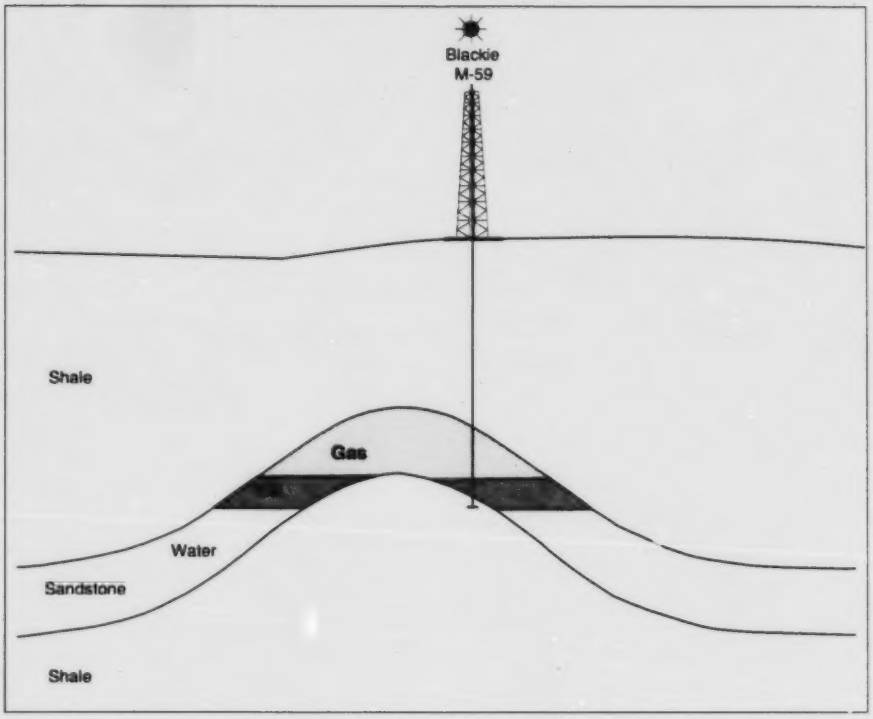
There is only one current discovery, the Blackie Field, which has gas trapped on water. Gas flowed on a DST at a maximum of 79 $10^3m^3/d$ with no recovered oil or condensate. There was a minor show of oil: traces of oil in a mud recovery on a DST mud recovery in the Birch B-34 well.

### *Potential resources*

The area of potential resources is limited by the subcrop of the unit near Chance and by outcropping along the southern edge of the basin. Although there is some potential for oil, gas is more likely, as indicated by testing and the maturity of the source rocks.

### *Reservoir parameters*

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| Blackie | gas | 1,599 | 17.7 | 15 | 70 | 45 | 594.0 (21.0) |
| Birch | oil | 0 | 1.8 | 8 | 0 | 0 | |



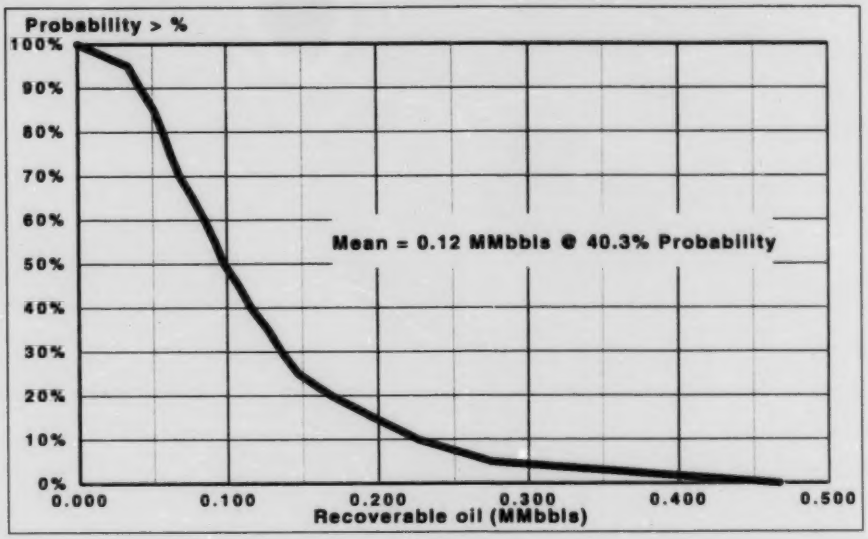
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 0.6000 | 0.6400 | 0.6600 | 0.633 |
| Tested play area (MM acres) | 0.060 | 0.060 | 0.060 | 0.060 |
| Untested play area (MM acres) | 0.540 | 0.580 | 0.600 | 0.573 |
| Fraction of total play area in trap | 0.120 | 0.160 | 0.180 | 0.153 |
| Fraction of untested play area filled (areally) | 0.300 | 0.500 | 0.700 | 0.500 |
| Potential hydrocarbon area (MM acres) | | | | 0.044 |
| Porosity | 0.050 | 0.100 | 0.150 | 0.100 |
| Hydrocarbon saturation | 0.600 | 0.700 | 0.800 | 0.700 |
| Oil recovery factor | 0.100 | 0.150 | 0.200 | 0.150 |
| Gas recovery factor | 0.400 | 0.550 | 0.800 | 0.583 |
| Average net pay (ft.) | 15.0 | 35.0 | 60.0 | 36.7 |
| Probability of hydrocarbons | 0.100 | 0.200 | 0.250 | 0.183 |
| Fraction of pore volume oil bearing | 0.001 | 0.005 | 0.010 | 0.005 |
| Potential oil area (MM acres) | | | | 0.000 |
| Potential gas area (MM acres) | | | | 0.008 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.190 | 0.200 | 0.210 | 0.200 |
| Formation volume factor (FVF) | 1.108 | 1.114 | 1.120 | 1.114 |
| Gas compressibility factor 'Z' | 0.800 | 0.900 | 0.950 | 0.883 |
| Gas volume factor (GVF) | | | | 0.059 |
| Oil in place (bbls/acre-foot) | | | | 487.5 |
| Oil recovery (bbls/acre-foot) | | | | 73.1 |
| Gas in place (MMcf/acre-foot) | | | | 179.2 |
| Raw gas recovery (MMcf/acre-foot) | | | | 104.5 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 100.5 |
| Liquid yield (bbls/MMcf) | 0.400 | 0.480 | 0.600 | 0.5 |
| $H_2S$ content | 0.000 | 0.000 | 0.000 | 0.000 |
| $CO_2$ content | 0.007 | 0.008 | 0.009 | 0.008 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.030 | | |
| Marketable gas (fraction of raw) | | 0.962 | | |

*Total for play*

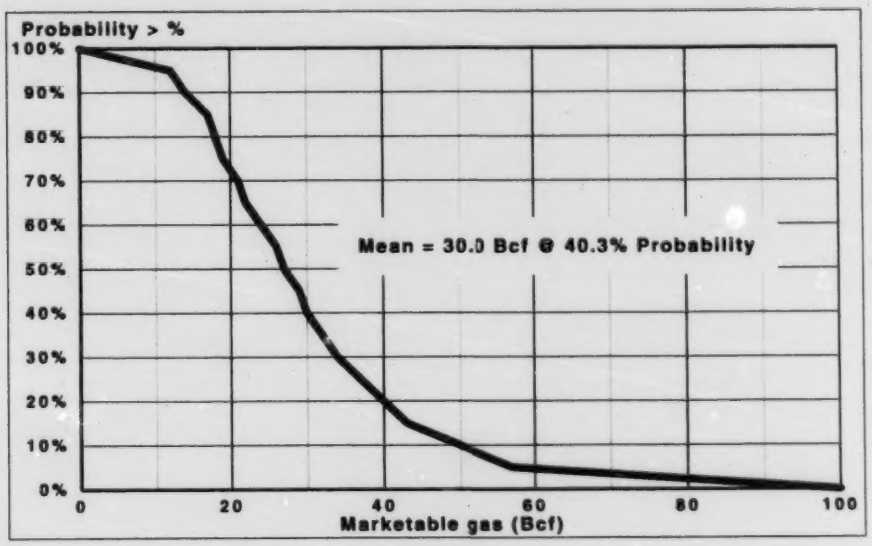
| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 0.77 | | 52.66 | 52.66 | | 9.54 | |
| **Recoverable** | 0.12 | 0.02 | 30.72 | 30.74 | 0.02 | 5.25 | 29.57 |
| **Sulphur (MMlt)** | | 0.00 | | | | | |

Oil depth: 2,000 ft.; gas depth: 2,000 ft.; gas pressure: 775 psi; gas reservoir temperature: 70°F




*Percentile values*

| | |
|---|---|
| 100% | 0.000 |
| 95% | 0.034 |
| 90% | 0.042 |
| 85% | 0.051 |
| 80% | 0.057 |
| 75% | 0.062 |
| 70% | 0.068 |
| 65% | 0.077 |
| 60% | 0.085 |
| 55% | 0.092 |
| 50% | 0.098 |
| 45% | 0.108 |
| 40% | 0.116 |
| 35% | 0.127 |
| 30% | 0.136 |
| 25% | 0.147 |
| 20% | 0.169 |
| 15% | 0.197 |
| 10% | 0.226 |
| 5% | 0.274 |
| 0% | 0.467 |




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 12 |
| 90% | 14 |
| 85% | 17 |
| 80% | 18 |
| 75% | 19 |
| 70% | 21 |
| 65% | 22 |
| 60% | 24 |
| 55% | 26 |
| 50% | 27 |
| 45% | 29 |
| 40% | 30 |
| 35% | 32 |
| 30% | 34 |
| 25% | 37 |
| 20% | 40 |
| 15% | 43 |
| 10% | 50 |
| 5% | 57 |
| 0% | 100 |

Carboniferous

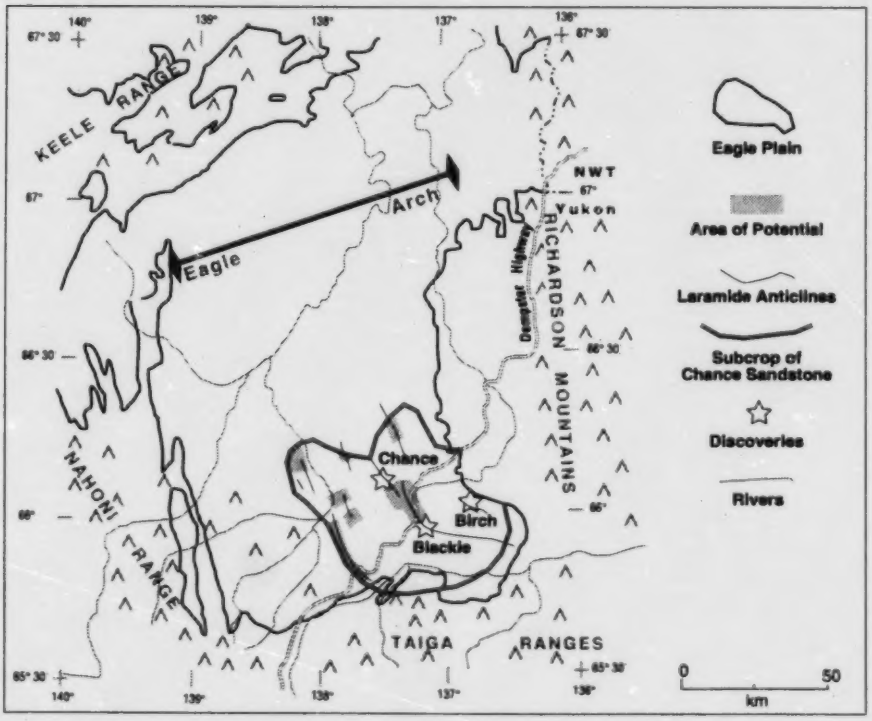
# CHANCE SANDSTONE STRUCTURAL

## ESTABLISHED GAS AND OIL PLAY

### *Reservoir description*

The Chance Sandstone play consists of closures formed by Laramide-aged anticlines, which may be partially influenced by normal faulting along north-south and east-west planes.

The Chance Member sandstone is described as thick units of grey- to buff-coloured, salt and pepper, very fine- to coarse-grained, fair to well sorted and are massive to thinly bedded. A maximum of 166 m of clean sandstone may be present. The unit subcrops to the north and west.



### *Discovered resources*

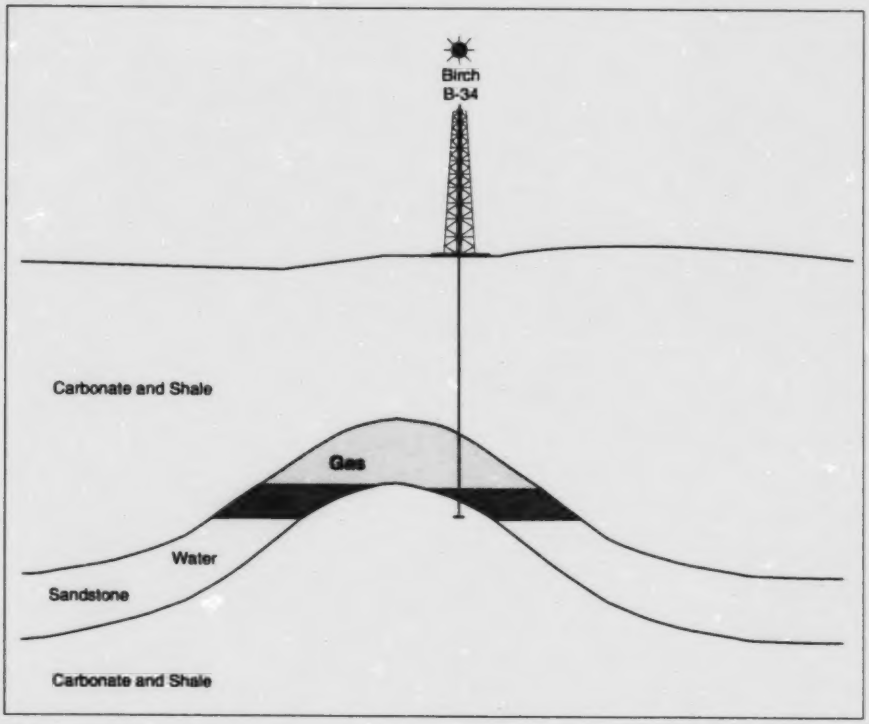
One discovery has been made in the Birch B-34 well, which has gas trapped on water. The gas flowed on a DST at a maximum of 194 $10^3m^3/d$ with no recovered oil or condensate.

### *Potential resources*

The area of potential resources is limited by the subcrop of the sandstone and the presence of structural deformation. There is potential for oil, as indicated by the oil in the sandstone at the Chance.

### *Reservoir parameters*

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| Birch | gas | 177 | 3.9 | 18 | 75 | 72 | 82.9 (2.9) |



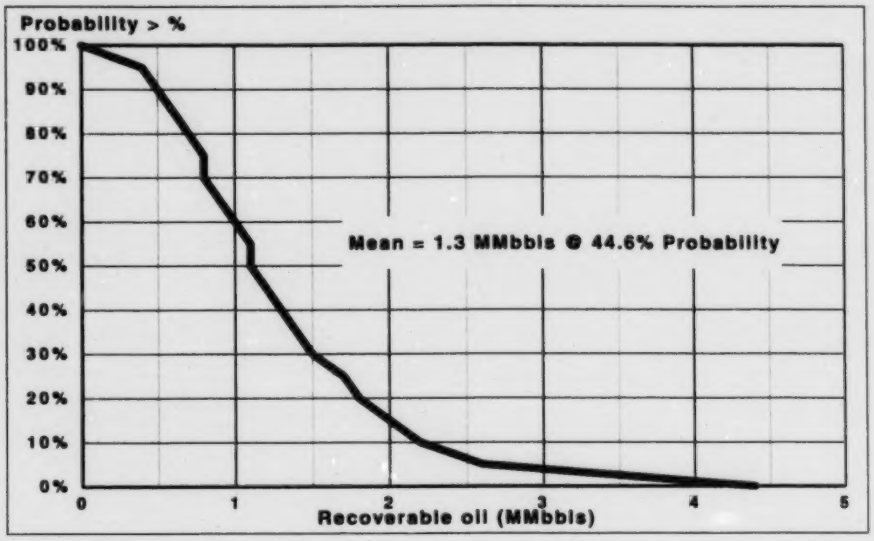
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 0.5500 | 0.5880 | 0.6000 | 0.579 |
| Tested play area (MM acres) | 0.072 | 0.072 | 0.072 | 0.072 |
| Untested play area (MM acres) | 0.478 | 0.516 | 0.528 | 0.507 |
| Fraction of total play area in trap | 0.100 | 0.140 | 0.180 | 0.140 |
| Fraction of untested play area filled (areally) | 0.300 | 0.500 | 0.700 | 0.500 |
| Potential hydrocarbon area (MM acres) | | | | 0.036 |
| Porosity | 0.090 | 0.180 | 0.220 | 0.163 |
| Hydrocarbon saturation | 0.550 | 0.750 | 0.900 | 0.733 |
| Oil recovery factor | 0.100 | 0.150 | 0.200 | 0.150 |
| Gas recovery factor | 0.550 | 0.720 | 0.800 | 0.690 |
| Average net pay (ft.) | 10.0 | 23.0 | 30.0 | 21.0 |
| Probability of hydrocarbons | 0.080 | 0.150 | 0.200 | 0.143 |
| Fraction of pore volume oil bearing | 0.020 | 0.100 | 0.200 | 0.107 |
| Potential oil area (MM acres) | | | | 0.001 |
| Potential gas area (MM acres) | | | | 0.005 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.399 | 0.420 | 0.441 | 0.420 |
| Formation volume factor (FVF) | 1.227 | 1.239 | 1.251 | 1.239 |
| Gas compressibility factor 'Z' | 0.764 | 0.780 | 0.796 | 0.780 |
| Gas volume factor (GVF) | | | | 0.279 |
| Oil in place (bbls/acre-foot) | | | | 749.7 |
| Oil recovery (bbls/acre-foot) | | | | 112.5 |
| Gas in place (MMcf/acre-foot) | | | | 1,453.9 |
| Raw gas recovery (MMcf/acre-foot) | | | | 1,003.2 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 938.0 |
| Liquid yield (bbls/MMcf) | 15.000 | 20.100 | 25.000 | 20.0 |
| $H_2S$ content | 0.000 | 0.000 | 0.000 | 0.000 |
| $CO_2$ content | 0.010 | 0.015 | 0.020 | 0.015 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.935 | | |

*Total for play*

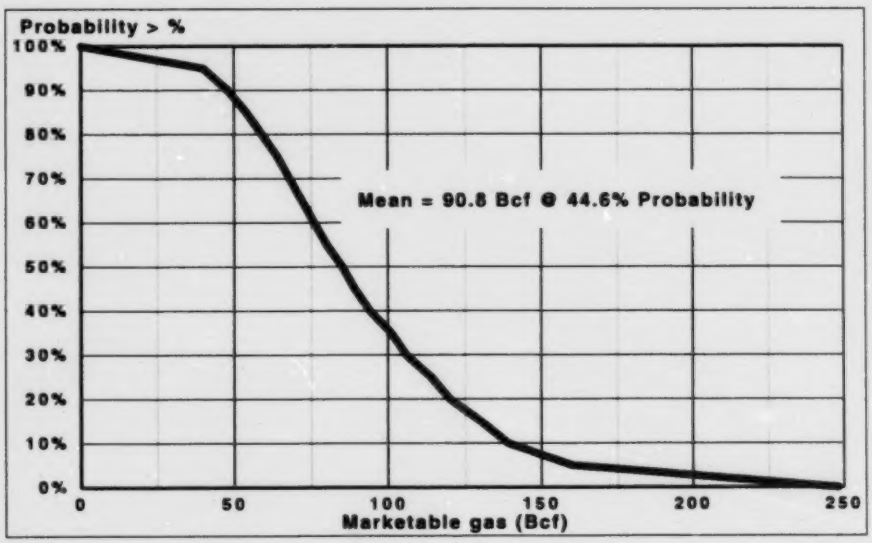
| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| In place | 8.55 | | 138.84 | 138.84 | | 31.69 | |
| Recoverable | 1.28 | 0.54 | 95.80 | 96.34 | 1.92 | 19.26 | 90.11 |
| Sulphur (MMlt) | | 0.00 | | | | | |

Oil depth: 4,200 ft.; gas depth: 4,200 ft.; gas pressure: 3,368 psi; gas reservoir temperature: 90°F




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 0.4 |
| 90% | 0.5 |
| 85% | 0.6 |
| 80% | 0.7 |
| 75% | 0.8 |
| 70% | 0.8 |
| 65% | 0.9 |
| 60% | 1.0 |
| 55% | 1.1 |
| 50% | 1.1 |
| 45% | 1.2 |
| 40% | 1.3 |
| 35% | 1.4 |
| 30% | 1.5 |
| 25% | 1.7 |
| 20% | 1.8 |
| 15% | 2.0 |
| 10% | 2.2 |
| 5% | 2.6 |
| 0% | 4.4 |




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 40 |
| 90% | 48 |
| 85% | 54 |
| 80% | 59 |
| 75% | 64 |
| 70% | 68 |
| 65% | 72 |
| 60% | 76 |
| 55% | 80 |
| 50% | 85 |
| 45% | 89 |
| 40% | 94 |
| 35% | 101 |
| 30% | 106 |
| 25% | 114 |
| 20% | 120 |
| 15% | 130 |
| 10% | 139 |
| 5% | 160 |
| 0% | 248 |

## Carboniferous

## CHANCE SANDSTONE UNCONFORMITY

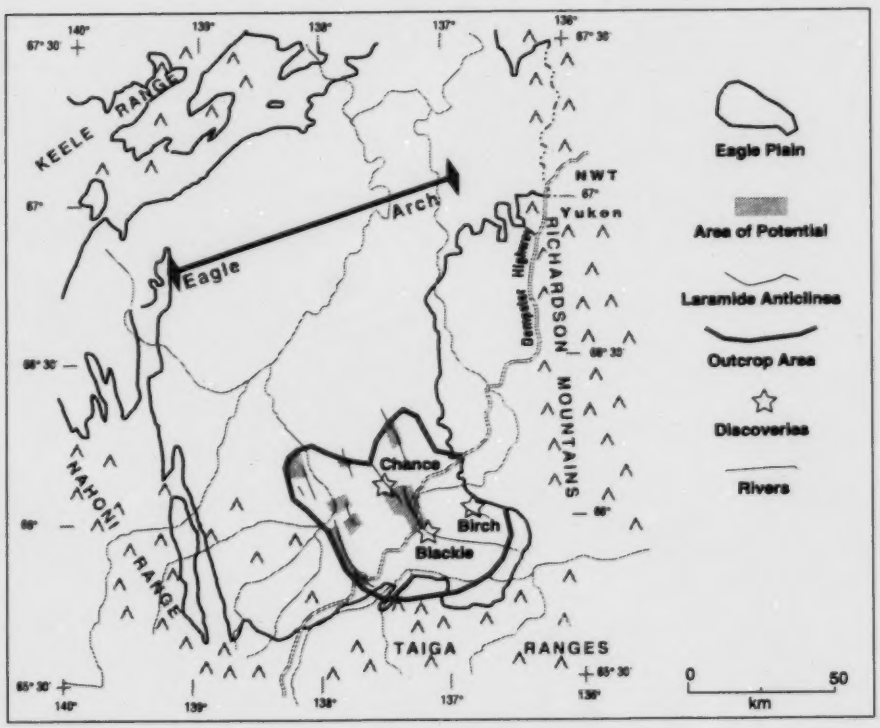
# ESTABLISHED GAS AND OIL PLAY

### *Reservoir description*

Carboniferous Chance Sandstone is subcropped by the pre-Cretaceous unconformity, leaving sandstone against Cretaceous shale to form a stratigraphic trap. This trap is enhanced by structural doming of the sandstone units during Laramide deformation. Chance sandstone and the associated Laramide anticlines have been discussed previously.

### *Discovered resources*

There is one discovery in the Chance Field with gas and/or oil trapped on top of water in a number of sandstone layers. Gas has flowed to the surface at varying rates on DSTs, to a maximum of 230 $10^3m^3/d$, while the maximum oil recovery was 610 $m^3$.

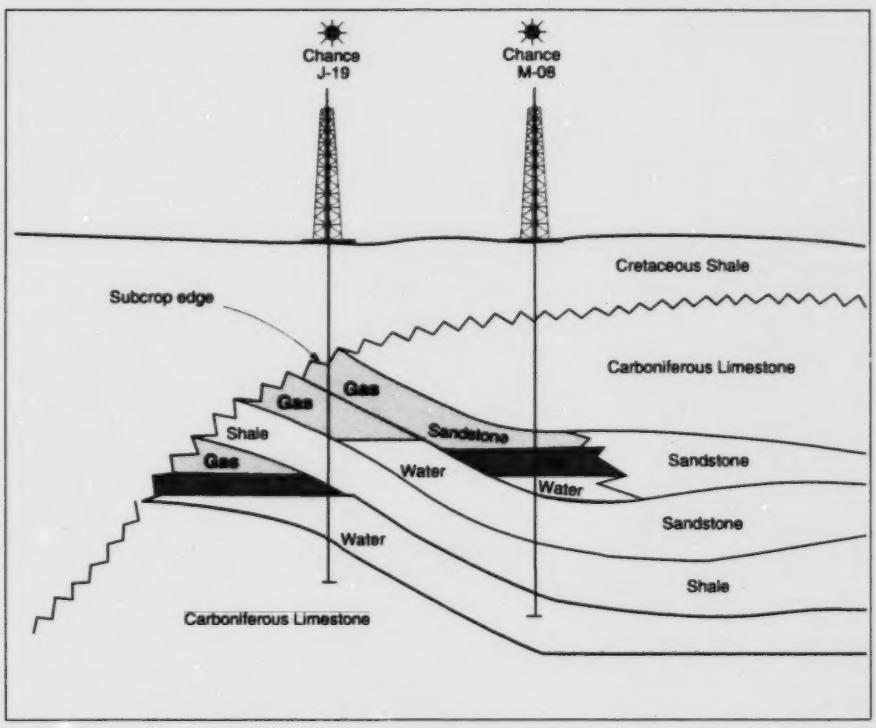


### *Potential resources*

The area of potential is limited by the subcrop of the sandstone and the need for folding. Both gas and oil pools are expected to be small, based on the current discovered pool sizes.

### *Reservoir Parameters*

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| Chance Sand #1 | gas | 416 | 15.0 | 14 | 55 | 75 | 496.4 (17.5) |
| Sand #2 | gas | 206 | 10.0 | 14 | 55 | 75 | 163.9 (5.8) |
| Sand #3 | gas | 369 | 10.0 | 10 | 55 | 75 | 209.7 (7.4) |
| Sand #1 | oil | 916 | 5.0 | 8 | 60 | 30 | 0.5 (3.2) |
| Sand #2 | oil | 87 | 1.4 | 5 | 60 | 30 | 0.01 (0.05) |
| Sand #3 | oil | 97 | 6.7 | 8 | 60 | 30 | 0.07 (0.45) |



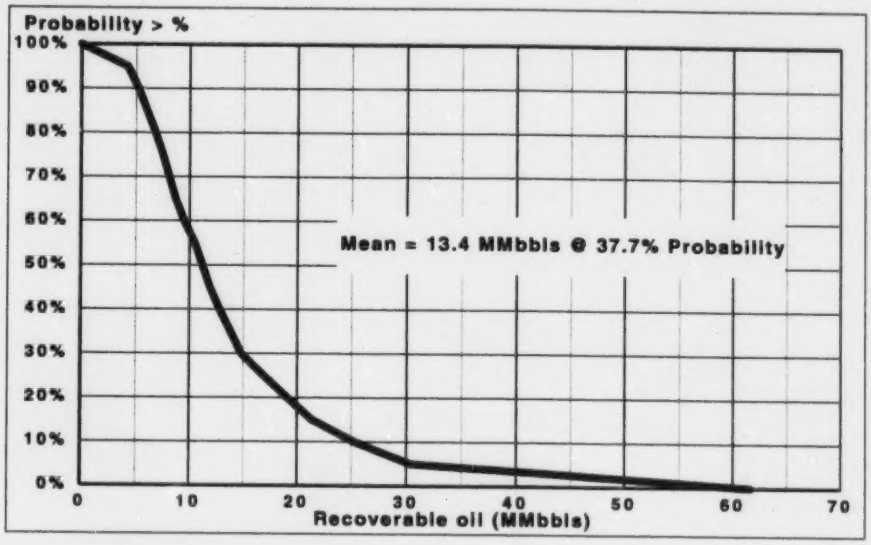
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 0.5800 | 0.5880 | 0.5900 | 0.586 |
| Tested play area (MM acres) | 0.066 | 0.066 | 0.066 | 0.066 |
| Untested play area (MM acres) | 0.514 | 0.522 | 0.524 | 0.520 |
| Fraction of total play area in trap | 0.090 | 0.150 | 0.200 | 0.147 |
| Fraction of untested play area filled (areally) | 0.500 | 0.700 | 0.900 | 0.700 |
| Potential hydrocarbon area (MM acres) | | | | 0.053 |
| Porosity | 0.090 | 0.130 | 0.230 | 0.150 |
| Hydrocarbon saturation | 0.500 | 0.550 | 0.750 | 0.600 |
| Oil recovery factor | 0.150 | 0.300 | 0.400 | 0.283 |
| Gas recovery factor | 0.600 | 0.750 | 0.900 | 0.750 |
| Average net pay (ft.) | 20.0 | 50.0 | 100.0 | 56.7 |
| Probability of hydrocarbons | 0.150 | 0.250 | 0.350 | 0.250 |
| Fraction of pore volume oil bearing | 0.030 | 0.100 | 0.200 | 0.110 |
| Potential oil area (MM acres) | | | | 0.001 |
| Potential gas area (MM acres) | | | | 0.012 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.399 | 0.420 | 0.441 | 0.420 |
| Formation volume factor (FVF) | 1.227 | 1.239 | 1.251 | 1.239 |
| Gas compressibility factor 'Z' | 0.774 | 0.790 | 0.806 | 0.790 |
| Gas volume factor (GVF) | | | | 0.171 |
| Oil in place (bbls/acre-foot) | | | | 563.4 |
| Oil recovery (bbls/acre-foot) | | | | 159.6 |
| Gas in place (MMcf/acre-foot) | | | | 669.3 |
| Raw gas recovery (MMcf/acre-foot) | | | | 502.0 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 457.8 |
| Liquid yield (bbls/MMcf) | 25.000 | 36.000 | 45.000 | 35.3 |
| $H_2S$ content | 0.001 | 0.001 | 0.002 | 0.001 |
| $CO_2$ content | 0.050 | 0.057 | 0.065 | 0.057 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.030 | | |
| Marketable gas (fraction of raw) | | 0.912 | | |

*Total for play*

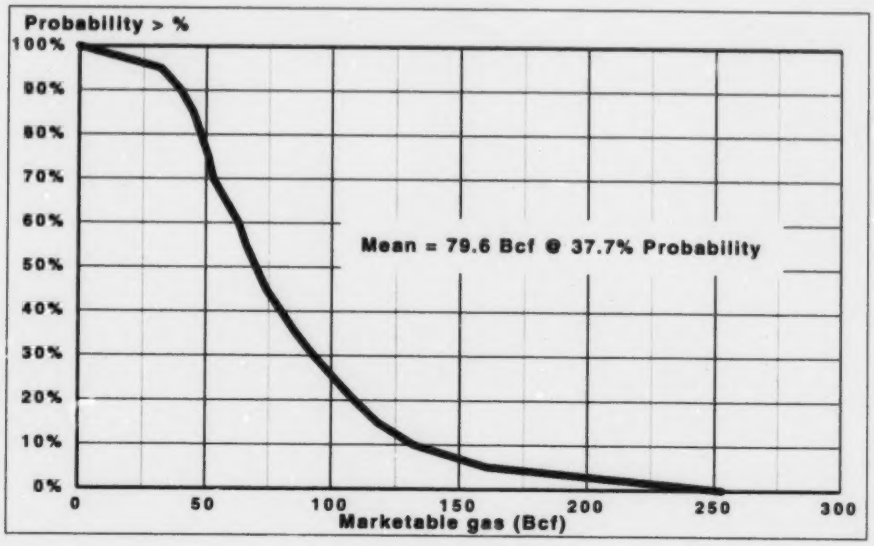
| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 47.00 | | 451.84 | 107.26 | | 64.74 | |
| **Recoverable** | 13.30 | 5.58 | 338.88 | 86.02 | 2.84 | 30.46 | 314.65 |
| **Sulphur (MMt)** | | 0.00 | | | | | |

Oil depth: 4,200 ft.; gas depth: 4,200 ft.; gas pressure: 4,363 psi; gas reservoir temperature: 90°F




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 4.2 |
| 90% | 5.2 |
| 85% | 6.0 |
| 80% | 6.8 |
| 75% | 7.5 |
| 70% | 8.1 |
| 65% | 8.7 |
| 60% | 9.5 |
| 55% | 10.5 |
| 50% | 11.2 |
| 45% | 11.9 |
| 40% | 12.8 |
| 35% | 13.8 |
| 30% | 14.8 |
| 25% | 16.9 |
| 20% | 19.1 |
| 15% | 21.4 |
| 10% | 25.3 |
| 5% | 30.4 |
| 0% | 61.6 |




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 32 |
| 90% | 40 |
| 85% | 45 |
| 80% | 48 |
| 75% | 51 |
| 70% | 53 |
| 65% | 58 |
| 60% | 63 |
| 55% | 66 |
| 50% | 70 |
| 45% | 74 |
| 40% | 80 |
| 35% | 86 |
| 30% | 93 |
| 25% | 101 |
| 20% | 109 |
| 15% | 118 |
| 10% | 132 |
| 5% | 161 |
| 0% | 253 |

## Carboniferous

## CHANCE SANDSTONE STRATIGRAPHIC

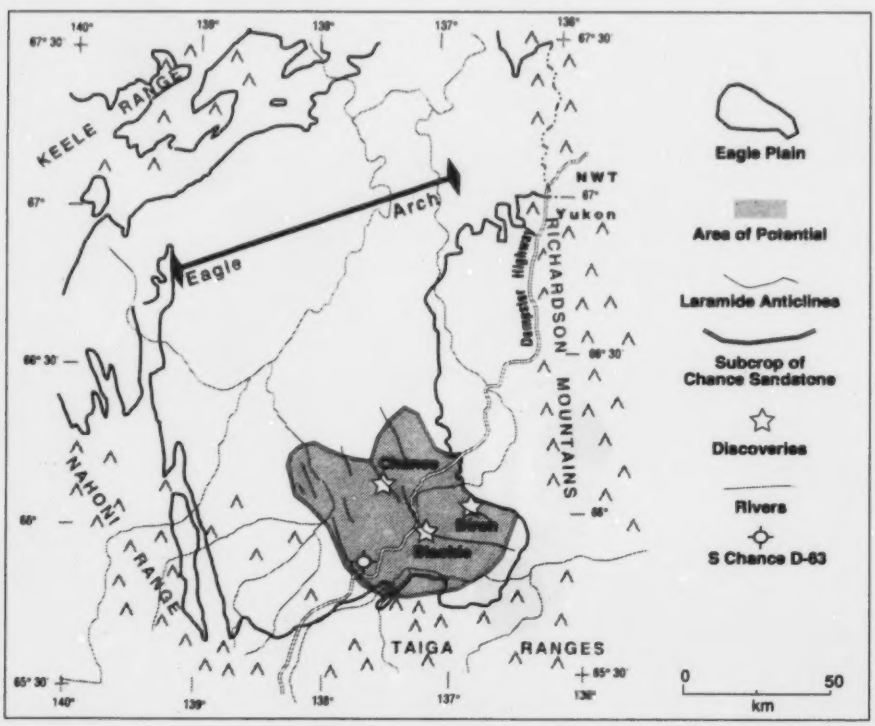
# ESTABLISHED GAS AND OIL PLAY

### *Reservoir description*

The Chance Sandstone stratigraphic facies change trap is created by porous sandstone pinching out of against non-porous sandstone. Trapping can be enhanced by dip reversals, but structural enhancement is not necessary. The Chance Sandstone is described under the Chance Sandstone – Laramide Folds play description.

### *Discovered resources*

The one oil discovery was in the Chance G-08 well. The oil is found to be structurally lower than the oil/water interface in the equivalent sand in the M-08 well nearby. The well recovered 360 m of oil on a DST. There has also been a gas show in the South Chance D-63 well which recovered gas-cut mud on a DST.

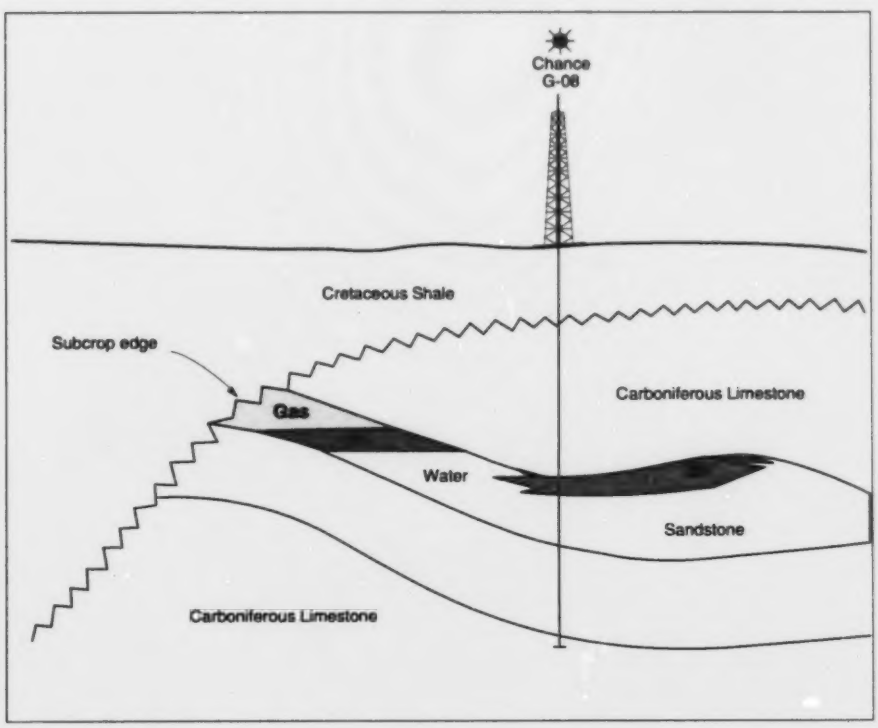


### *Undiscovered resources*

The area of potential is limited only by the subcrop of the sandstone, as folding is not a factor. Both small gas and oil pools can be expected, with equal probabilities. Pool sizes are expected to be small since reservoirs can be pinched out by cementation or subcropped by the erosional edge.

### *Reservoir parameters*

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| South Chance D-63 | gas | 0 | 7.0 | 8 | 75 | - | 0 (0) |
| Chance Sand 1A | oil | 802 | 5.0 | 6 | 60 | 30 | 0.4 (2.2) |



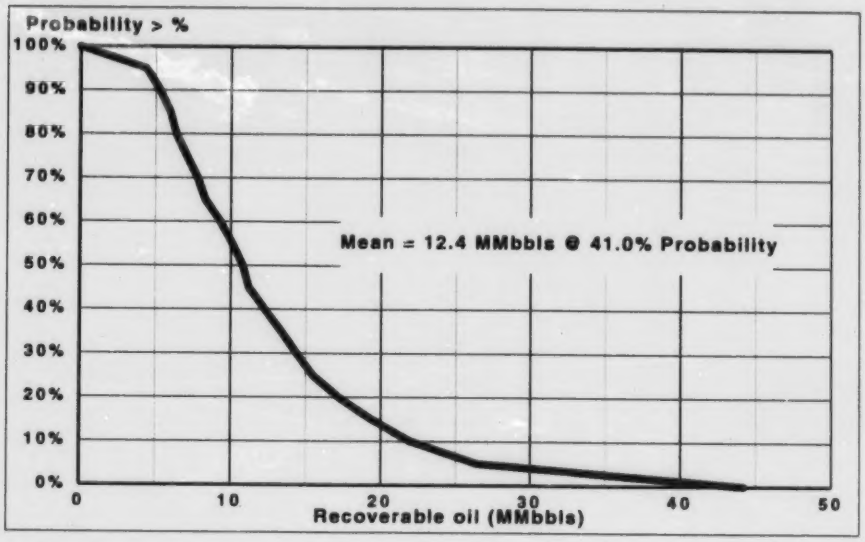
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 0.5650 | 0.5880 | 0.6000 | 0.584 |
| Tested play area (MM acres) | 0.085 | 0.085 | 0.085 | 0.085 |
| Untested play area (MM acres) | 0.480 | 0.503 | 0.515 | 0.499 |
| Fraction of total play area in trap | 0.300 | 0.500 | 0.800 | 0.533 |
| Fraction of untested play area filled (areally) | 0.400 | 0.700 | 0.900 | 0.667 |
| Potential hydrocarbon area (MM acres) | | | | 0.178 |
| Porosity | 0.060 | 0.070 | 0.100 | 0.077 |
| Hydrocarbon saturation | 0.500 | 0.600 | 0.800 | 0.633 |
| Oil recovery factor | 0.150 | 0.300 | 0.400 | 0.283 |
| Gas recovery factor | 0.600 | 0.750 | 0.900 | 0.750 |
| Average net pay (ft.) | 10.0 | 30.0 | 45.0 | 28.3 |
| Probability of hydrocarbons | 0.090 | 0.200 | 0.300 | 0.197 |
| Fraction of pore volume oil bearing | 0.080 | 0.150 | 0.200 | 0.143 |
| Potential oil area (MM acres) | | | | 0.005 |
| Potential gas area (MM acres) | | | | 0.030 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.399 | 0.420 | 0.441 | 0.420 |
| Formation volume factor (FVF) | 1.227 | 1.239 | 1.251 | 1.239 |
| Gas compressibility factor 'Z' | 0.774 | 0.790 | 0.806 | 0.790 |
| Gas volume factor (GVF) | | | | 0.149 |
| Oil in place (bbls/acre-foot) | | | | 305.1 |
| Oil recovery (bbls/acre-foot) | | | | 86.3 |
| Gas in place (MMcf/acre-foot) | | | | 317.2 |
| Raw gas recovery (MMcf/acre-foot) | | | | 237.9 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 219.1 |
| Liquid yield (bbls/MMcf) | 20.000 | 28.000 | 35.000 | 27.7 |
| $H_2S$ content | 0.000 | 0.000 | 0.000 | 0.000 |
| $CO_2$ content | 0.022 | 0.029 | 0.035 | 0.029 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.921 | | |

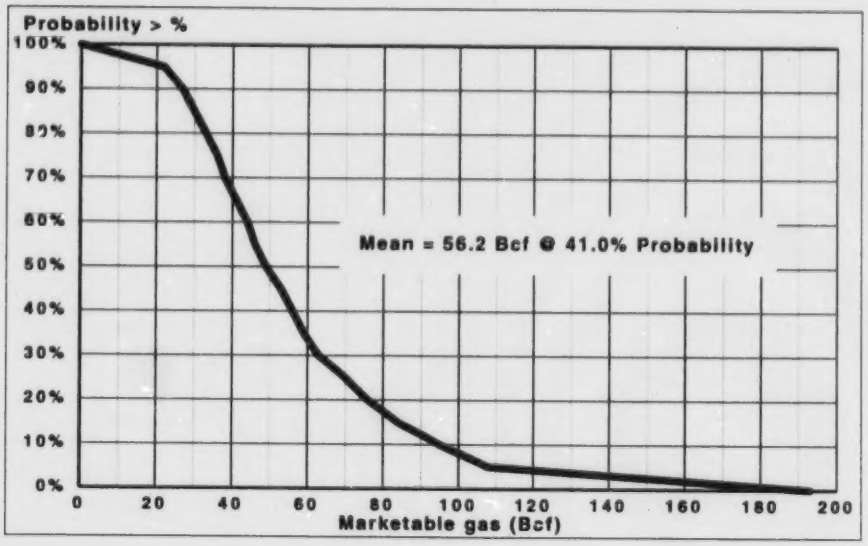
*Total for play*

| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 43.10 | | 268.88 | 72.86 | | 55.24 | |
| **Recoverable** | 12.21 | 5.13 | 210.66 | 59.77 | 1.51 | 23.68 | 190.86 |
| **Sulphur (MMlt)** | | | | | | | |

Oil depth: 4,200 ft.; gas depth: 4,200 ft.; gas pressure: 4,363 psi; gas reservoir temperature: 90°F




| *Percentile values* | |
|---|---|
| 100% | 0 |
| 95% | 4.4 |
| 90% | 5.3 |
| 85% | 6.0 |
| 80% | 6.4 |
| 75% | 7.1 |
| 70% | 7.8 |
| 65% | 8.3 |
| 60% | 9.3 |
| 55% | 10.1 |
| 50% | 10.8 |
| 45% | 11.2 |
| 40% | 12.3 |
| 35% | 13.4 |
| 30% | 14.4 |
| 25% | 15.5 |
| 20% | 17.2 |
| 15% | 19.4 |
| 10% | 22.0 |
| 5% | 26.4 |
| 0% | 44.2 |




| *Percentile values* | |
|---|---|
| 100% | 0 |
| 95% | 22 |
| 90% | 27 |
| 85% | 30 |
| 80% | 33 |
| 75% | 36 |
| 70% | 38 |
| 65% | 41 |
| 60% | 44 |
| 55% | 46 |
| 50% | 49 |
| 45% | 53 |
| 40% | 56 |
| 35% | 59 |
| 30% | 63 |
| 25% | 70 |
| 20% | 76 |
| 15% | 84 |
| 10% | 95 |
| 5% | 108 |
| 0% | 193 |

## Carboniferous

## CANOE RIVER LIMESTONE

# ESTABLISHED GAS AND OIL PLAY

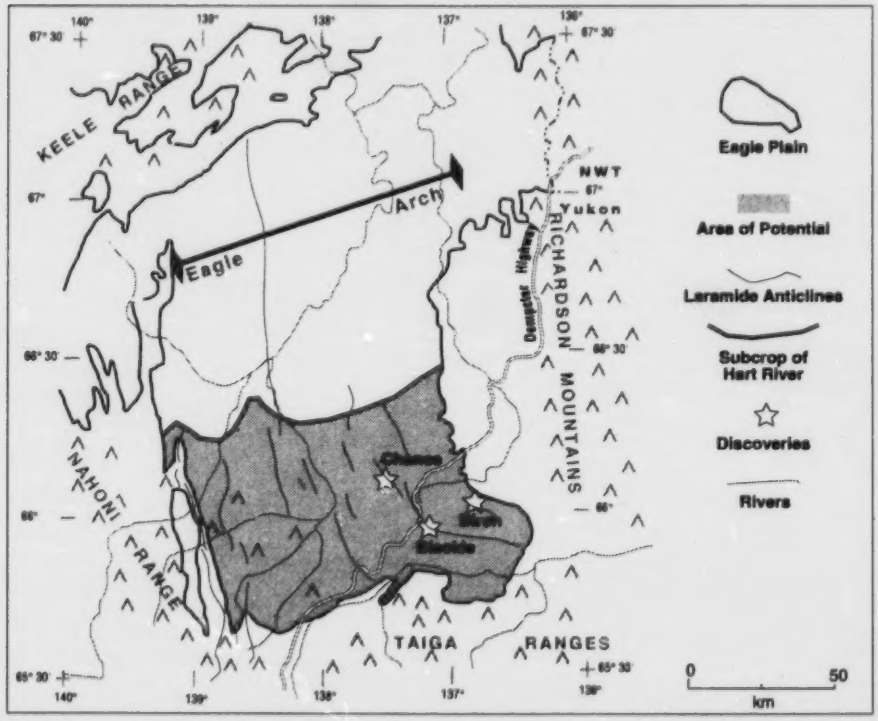
### *Reservoir description*

Carboniferous Canoe River limestone stratigraphic facies change traps are the result of porous carbonate pinching out against non-porous carbonate associated with a clearly defined facies boundary within the same formation, or against other non-porous formations. Reservoirs may or may not be enhanced by Laramide structures.

The Canoe River Member is the lower limestone of the Hart River Formation. It is described as a thinly bedded micritic crinoidal limestone with interbeds of dolomite, chert and dark bioturbated shale. The unit is subcropped by the pre-Cretaceous unconformity in the north and thins rapidly to the south. A maximum thickness of 500 m can be expected.

### *Discovered resources*

One discovery and one show have been made in two wells in the Chance Field. The J-19 well has a porous limey sandstone at the top of the Canoe River Member that has gas trapped on water. A test of this zone recovered gas-cut mud. The M-08 well has a porous limey sandstone section within the Canoe River Member that has gas trapped on oil on water. A test flowed gas at 283 $10^3m^3/d$ and recovered 290 $m^3$ of oil. Zones are highly fractured.

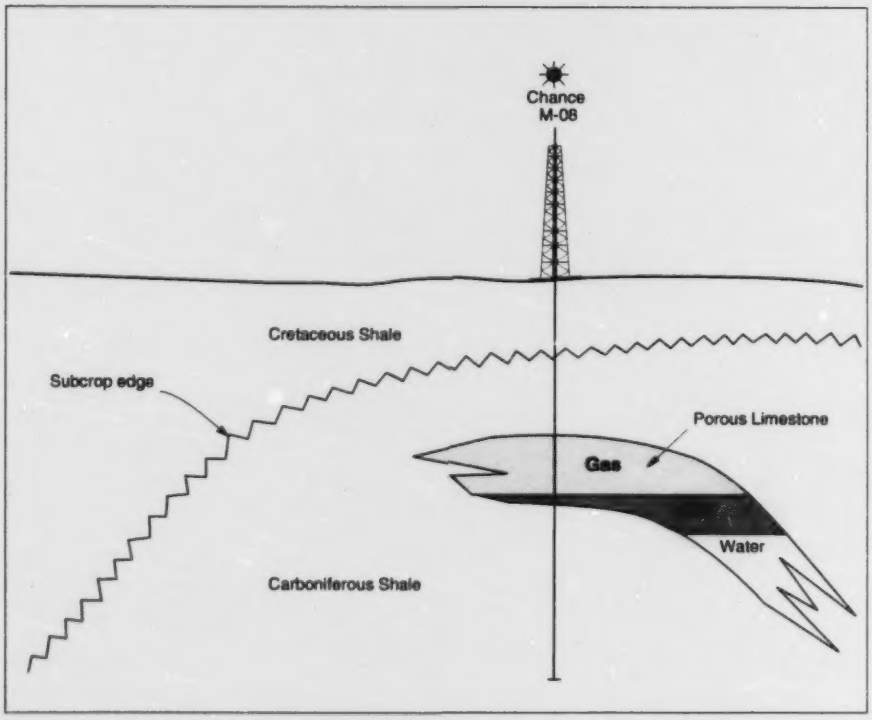


### *Potential resources*

The area of potential is limited by the subcrop edge. Fracturing may be necessary for economic production rates. Both oil and gas are possible, but gas is considered to be more likely, based on results to date.

### *Reservoir parameters*

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| Chance J-19 | gas | 229 | 2.5 | 13 | 70 | 65 | 40.8 (1.44) |
| M-08 | gas | 168 | 1.0 | 3 | 60 | 50 | 1.24 (0.04) |
| M-08 | oil | 168 | 0.7 | 3 | 60 | 20 | 0.15 (0.02) |



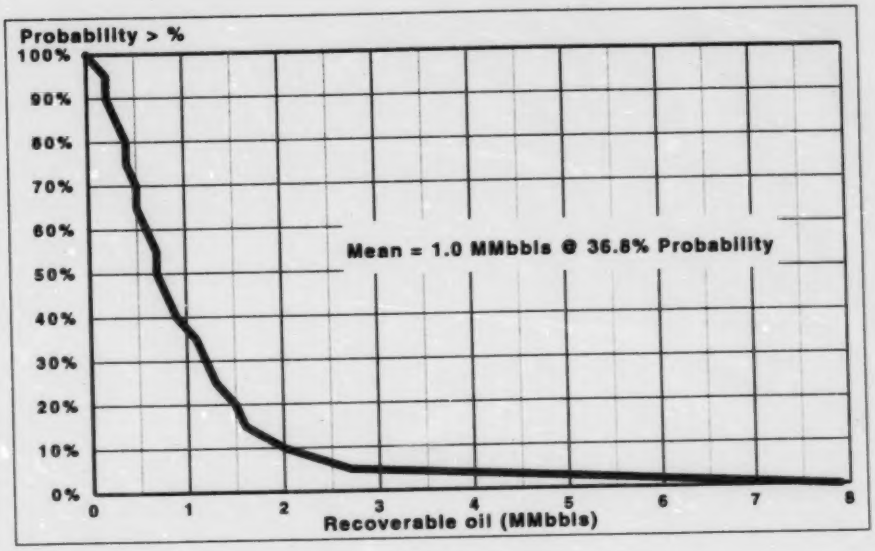
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 1.0000 | 1.2000 | 1.2500 | 1.150 |
| Tested play area (MM acres) | 0.130 | 0.130 | 0.130 | 0.130 |
| Untested play area (MM acres) | 0.870 | 1.070 | 1.120 | 1.020 |
| Fraction of total play area in trap | 0.020 | 0.100 | 0.300 | 0.140 |
| Fraction of untested play area filled (areally) | 0.500 | 0.850 | 0.950 | 0.767 |
| Potential hydrocarbon area (MM acres) | | | | 0.109 |
| Porosity | 0.030 | 0.065 | 0.150 | 0.082 |
| Hydrocarbon saturation | 0.500 | 0.650 | 0.750 | 0.633 |
| Oil recovery factor | 0.100 | 0.200 | 0.300 | 0.200 |
| Gas recovery factor | 0.500 | 0.600 | 0.750 | 0.617 |
| Average net pay (ft.) | 2.0 | 9.0 | 20.0 | 10.3 |
| Probability of hydrocarbons | 0.050 | 0.150 | 0.240 | 0.147 |
| Fraction of pore volume oil bearing | 0.040 | 0.100 | 0.150 | 0.097 |
| Potential oil area (MM acres) | | | | 0.002 |
| Potential gas area (MM acres) | | | | 0.015 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.485 | 0.510 | 0.536 | 0.510 |
| Formation volume factor (FVF) | 1.276 | 1.291 | 1.305 | 1.291 |
| Gas compressibility factor 'Z' | 0.833 | 0.850 | 0.867 | 0.850 |
| Gas volume factor (GVF) | | | | 0.289 |
| Oil in place (bbls/acre-foot) | | | | 310.9 |
| Oil recovery (bbls/acre-foot) | | | | 62.2 |
| Gas in place (MMcf/acre-foot) | | | | 651.2 |
| Raw gas recovery (MMcf/acre-foot) | | | | 401.6 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 358.6 |
| Liquid yield (bbls/MMcf) | 27.0 | 35.6 | 44.5 | 35.7 |
| $H_2S$ content | 0.0 | 0.0 | 0.0 | 0.000 |
| $CO_2$ content | 0.020 | 0.057 | 0.100 | 0.059 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.893 | | |

*Total for play*

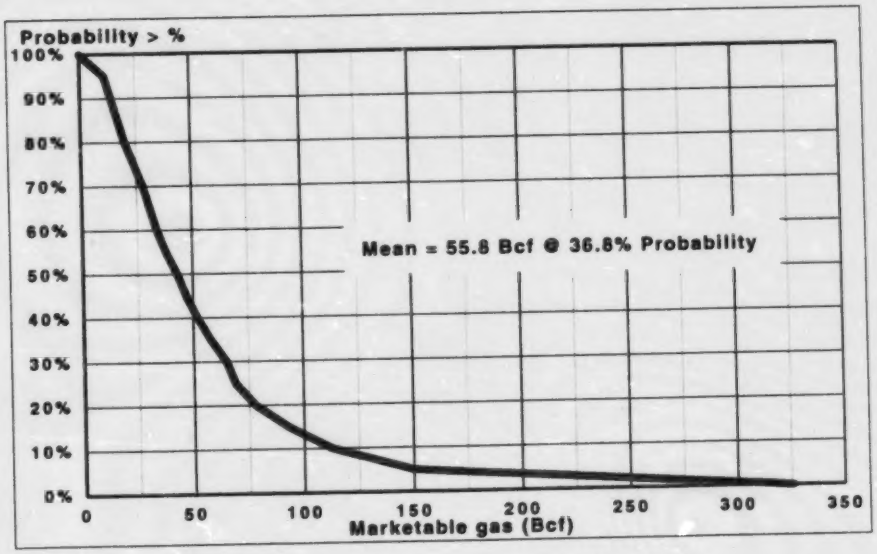
| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 4.99 | | 97.61 | 97.61 | | 21.25 | |
| **Recoverable** | 1.00 | 0.51 | 60.19 | 60.70 | 2.15 | 13.26 | 54.26 |
| **Sulphur (MMt)** | | 0.00 | | | | | |

Oil depth: 5,100 ft.; gas depth: 5,100 ft.; gas pressure: 3,994 psi; gas reservoir temperature: 117°F




***Percentile values***

| | |
|---|---|
| 100% | 0 |
| 95% | 0.2 |
| 90% | 0.2 |
| 85% | 0.3 |
| 80% | 0.4 |
| 75% | 0.4 |
| 70% | 0.5 |
| 65% | 0.5 |
| 60% | 0.6 |
| 55% | 0.7 |
| 50% | 0.7 |
| 45% | 0.8 |
| 40% | 0.9 |
| 35% | 1.1 |
| 30% | 1.2 |
| 25% | 1.3 |
| 20% | 1.5 |
| 15% | 1.6 |
| 10% | 2.0 |
| 5% | 2.7 |
| 0% | 7.9 |




***Percentile values***

| | |
|---|---|
| 100% | 0 |
| 95% | 11 |
| 90% | 14 |
| 85% | 17 |
| 80% | 20 |
| 75% | 24 |
| 70% | 28 |
| 65% | 31 |
| 60% | 34 |
| 55% | 38 |
| 50% | 43 |
| 45% | 47 |
| 40% | 52 |
| 35% | 58 |
| 30% | 65 |
| 25% | 69 |
| 20% | 78 |
| 15% | 93 |
| 10% | 113 |
| 5% | 150 |
| 0% | 326 |

## Carboniferous

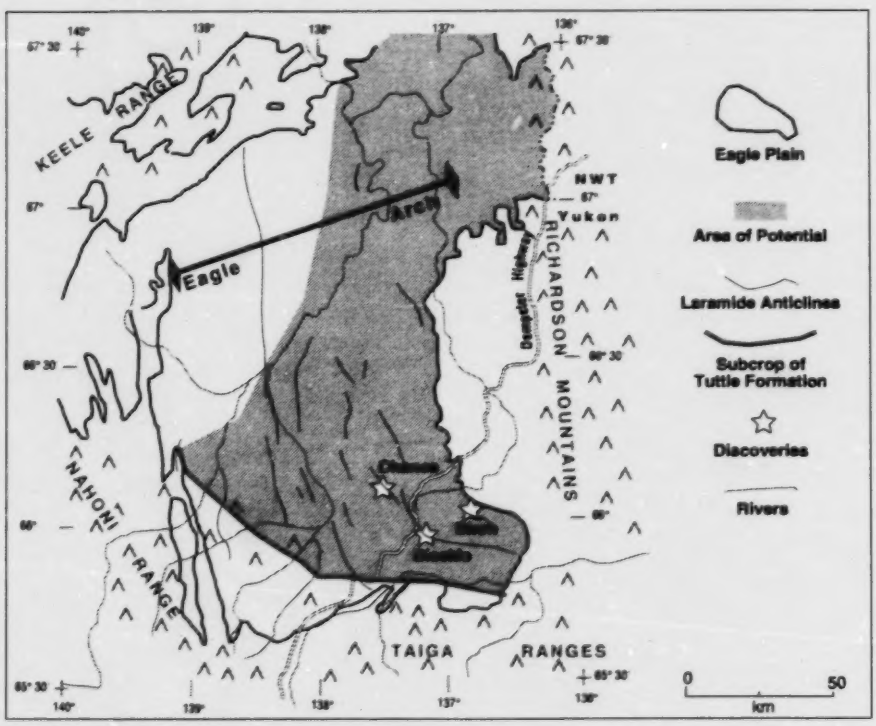
## TUTTLE FORMATION

# ESTABLISHED GAS PLAY

### *Reservoir description*

The Tuttle Formation is a stratigraphic facies change play that occurs where the Tuttle Formation pinches out into the Lower Carboniferous Ford Lake shale or against the Upper Devonian Imperial shale, or where the sandstone bodies pinch out within the formation. Trapping is enhanced by structure but it is not necessary for this play.

The Tuttle Formation is a mixture of chert conglomerate, very poorly sorted quartz and chert sandstone, siltstone and shale. It is distinguished by the presence of presence of kaolinite and quartz in the pores and by orthoquartzite beds. The sands are fluviodeltaic in nature and are thought to have a northeast source. There are variable amounts of sandstone in the basin and the maximum thickness is 1,420 m.



### *Discovered resources*

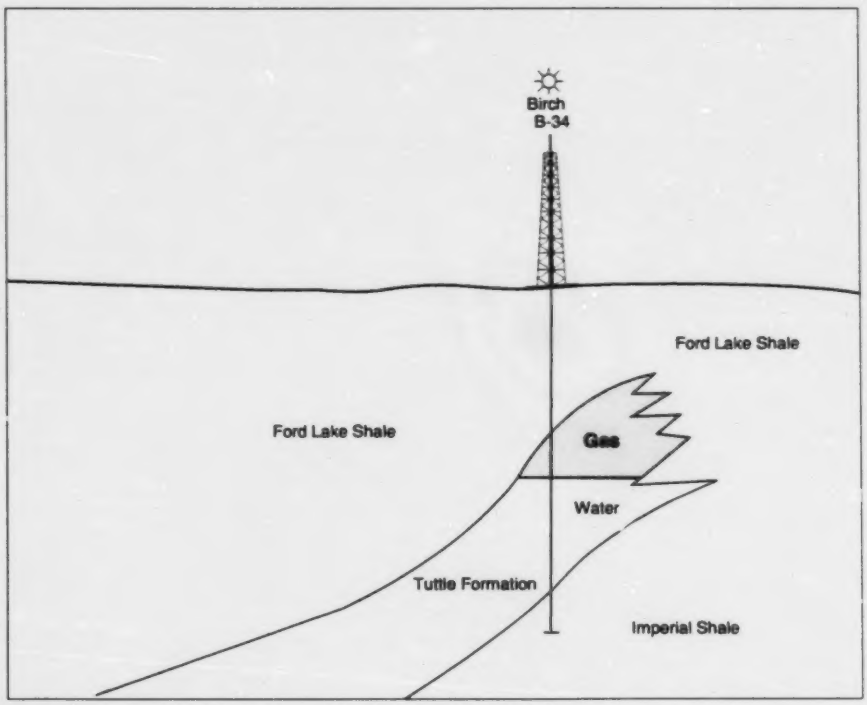
There have been discoveries at Chance and Birch, both of which are enhanced by Laramide structures. At Chance, the zone has gas trapped on water and tested gas at a maximum of 283 $10^3m^3/d$. At Birch, there is no water leg and the zone tested at a maximum of 258 $10^3m^3/d$.

### *Potential resources*

The area of potential resources is controlled by pinchout of the sandstone to the northwest and by its subcrop to the southwest. This is considered to be a gas play.

### *Reservoir parameters*

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| Chance | gas | 168 | 1.8 | 16 | 90 | 60 | 32.2 (1.14) |
| Birch | gas | 229 | 6.1 | 5.0 | 72 | 70 | 48.3 (1.7) |



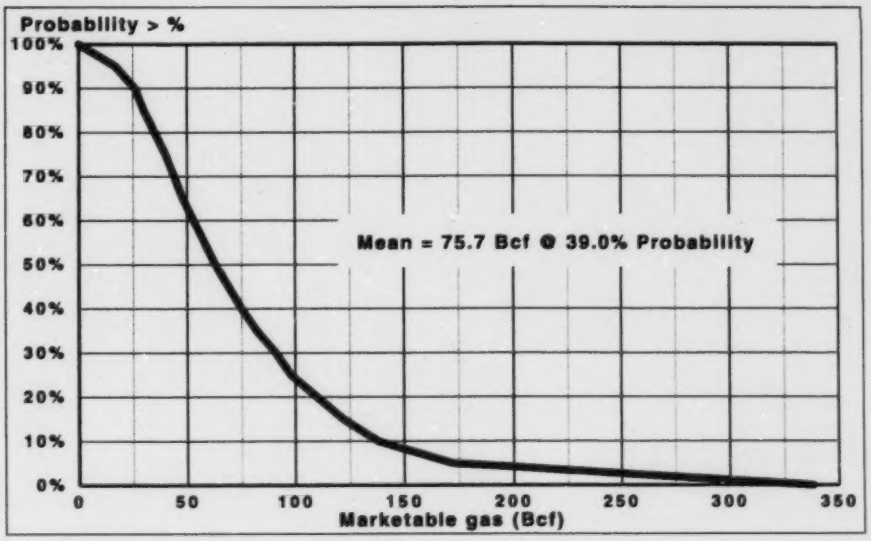
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 0.8500 | 2.3300 | 3.8000 | 2.327 |
| Tested play area (MM acres) | 0.130 | 0.130 | 0.130 | 0.130 |
| Untested play area (MM acres) | 0.720 | 2.200 | 3.670 | 2.197 |
| Fraction of total play area in trap | 0.040 | 0.100 | 0.150 | 0.097 |
| Fraction of untested play area filled (areally) | 0.250 | 0.400 | 0.550 | 0.400 |
| Potential hydrocarbon area (MM acres) | | | | 0.085 |
| Porosity | 0.050 | 0.070 | 0.110 | 0.077 |
| Hydrocarbon saturation | 0.600 | 0.800 | 0.900 | 0.767 |
| Oil recovery factor | 0.100 | 0.200 | 0.300 | 0.200 |
| Gas recovery factor | 0.550 | 0.650 | 0.750 | 0.650 |
| Average net pay (ft.) | 4.0 | 13.0 | 25.0 | 14.0 |
| Probability of hydrocarbons | 0.040 | 0.100 | 0.250 | 0.130 |
| Fraction of pore volume oil bearing | 0.000 | 0.000 | 0.000 | 0.000 |
| Potential oil area (MM acres) | | | | 0.000 |
| Potential gas area (MM acres) | | | | 0.011 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.585 | 0.616 | 0.647 | 0.616 |
| Formation volume factor (FVF) | 1.334 | 1.351 | 1.369 | 1.351 |
| Gas compressibility factor 'Z' | 0.804 | 0.820 | 0.836 | 0.820 |
| Gas volume factor (GVF) | | | | 0.314 |
| Oil in place (bbls/acre-foot) | | | | 337.5 |
| Oil recovery (bbls/acre-foot) | | | | 67.5 |
| Gas in place (MMcf/acre-foot) | | | | 803.8 |
| Raw gas recovery (MMcf/acre-foot) | | | | 522.4 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 490.4 |
| Liquid yield (bbls/MMcf) | 12.0 | 15.9 | 19.9 | 15.9 |
| $H_2S$ content | 0.000 | 0.000 | 0.020 | 0.007 |
| $CO_2$ content | 0.005 | 0.011 | 0.020 | 0.012 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.939 | | |

*Total for play*

| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 0.00 | | 124.25 | 124.25 | | 20.71 | |
| **Recoverable** | 0.00 | 0.00 | 80.76 | 80.76 | 1.29 | 14.75 | 75.81 |
| **Sulphur (MMlt)** | | 0.02 | | | | | |

Oil depth: 6,160 ft.; gas depth: 6,160 ft.; gas pressure: 4,083 psi; gas reservoir temperature: 103°F




| *Percentile values* | |
|---|---|
| 100% | 0 |
| 95% | 17 |
| 90% | 26 |
| 85% | 30 |
| 80% | 35 |
| 75% | 40 |
| 70% | 44 |
| 65% | 48 |
| 60% | 53 |
| 55% | 58 |
| 50% | 63 |
| 45% | 69 |
| 40% | 75 |
| 35% | 82 |
| 30% | 91 |
| 25% | 98 |
| 20% | 110 |
| 15% | 122 |
| 10% | 138 |
| 5% | 172 |
| 0% | 338 |

# TRIANGLE ZONE STRUCTURAL

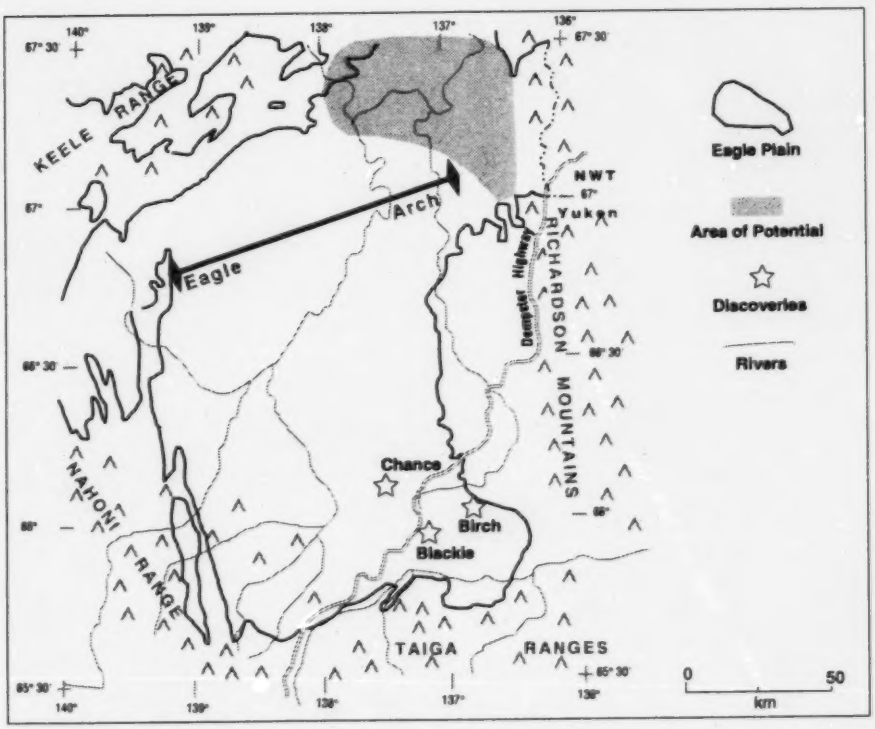
## IMMATURE GAS PLAY

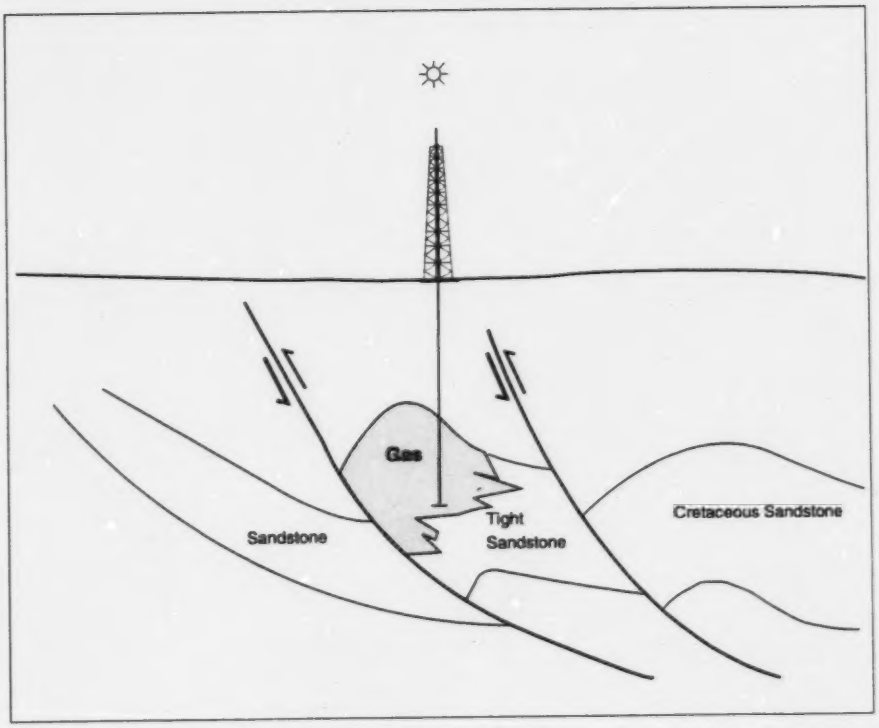
### *Reservoir description*

Triangle zone structures are formed by thrust faulting in the Bell Sub-basin. This faulting occurred during the Laramide Orogeny as the surrounding mountains of the Dave Lord and Nahonni ranges of the Richardson Mountains were formed. These structures have not been found in the South Eagle Sub-basin. The presence of duplex and related structures have been interpreted on seismic sections within the sub-basin in the northeast. Structuring could involve Cretaceous clastics of the Eagle Plain Group.

### *Undiscovered resources*

No wells have been drilled for these targets as they have only recently been researched at the Geological Survey of Canada in Calgary. The area of potential is restricted to the northeastern part of the basin. This is also expected to be a gas play.




Gas
Tight
Sandstone
Sandstone
Cretaceous Sandstone

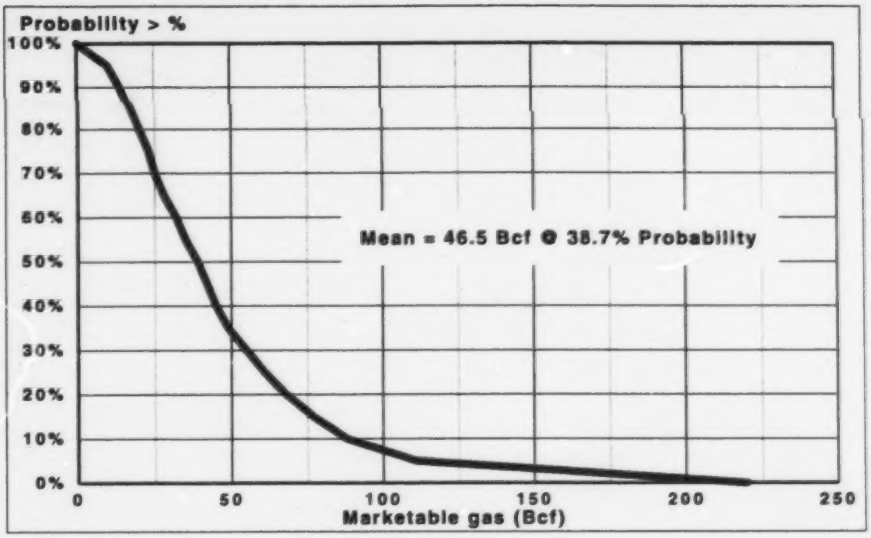
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 0.3500 | 0.5400 | 1.0000 | 0.630 |
| Tested play area (MM acres) | 0.000 | 0.000 | 0.000 | 0.000 |
| Untested play area (MM acres) | 0.350 | 0.540 | 1.000 | 0.630 |
| Fraction of total play area in trap | 0.030 | 0.100 | 0.200 | 0.110 |
| Fraction of untested play area filled (areally) | 0.300 | 0.600 | 0.900 | 0.600 |
| Potential hydrocarbon area (MM acres) | | | | 0.042 |
| Porosity | 0.050 | 0.120 | 0.220 | 0.130 |
| Hydrocarbon saturation | 0.500 | 0.650 | 0.750 | 0.633 |
| Oil recovery factor | 0.050 | 0.150 | 0.250 | 0.150 |
| Gas recovery factor | 0.700 | 0.750 | 0.850 | 0.767 |
| Average net pay (ft.) | 10.0 | 16.0 | 26.0 | 17.3 |
| Probability of hydrocarbons | 0.010 | 0.100 | 0.200 | 0.103 |
| Fraction of pore volume oil bearing | 0.000 | 0.000 | 0.000 | 0.000 |
| Potential oil area (MM acres) | | | | 0.000 |
| Potential gas area (MM acres) | | | | 0.004 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.380 | 0.400 | 0.420 | 0.400 |
| Formation volume factor (FVF) | 1.217 | 1.228 | 1.239 | 1.228 |
| Gas compressibility factor 'Z' | 0.882 | 0.900 | 0.918 | 0.900 |
| Gas volume factor (GVF) | | | | 0.246 |
| Oil in place (bbls/acre-foot) | | | | 520.1 |
| Oil recovery (bbls/acre-foot) | | | | 78.0 |
| Gas in place (MMcf/acre-foot) | | | | 884.0 |
| Raw gas recovery (MMcf/acre-foot) | | | | 677.8 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 623.5 |
| Liquid yield (bbls/MMcf) | 4.0 | 5.1 | 6.4 | 5.2 |
| $H_2S$ content | 0.000 | 0.000 | 0.000 | 0.000 |
| $CO_2$ content | 0.010 | 0.030 | 0.050 | 0.030 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.920 | | |

*Total for play*

| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | | 0.00 | | 65.84 | 65.84 | | 10.97 |
| **Recoverable** | 0.00 | 0.00 | 50.47 | 50.47 | 0.26 | 8.67 | 46.44 |
| **Sulphur (MMlt)** | | 0.00 | | | | | |

Oil depth: 4,000 ft; gas depth: 4,100 ft.; gas pressure: 3,500 psi; gas reservoir temperature: 100°F




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 10 |
| 90% | 14 |
| 85% | 17 |
| 80% | 20 |
| 75% | 23 |
| 70% | 25 |
| 65% | 28 |
| 60% | 32 |
| 55% | 35 |
| 50% | 39 |
| 45% | 42 |
| 40% | 45 |
| 35% | 49 |
| 30% | 55 |
| 25% | 61 |
| 20% | 68 |
| 15% | 77 |
| 10% | 88 |
| 5% | 111 |
| 0% | 220 |

## Carboniferous

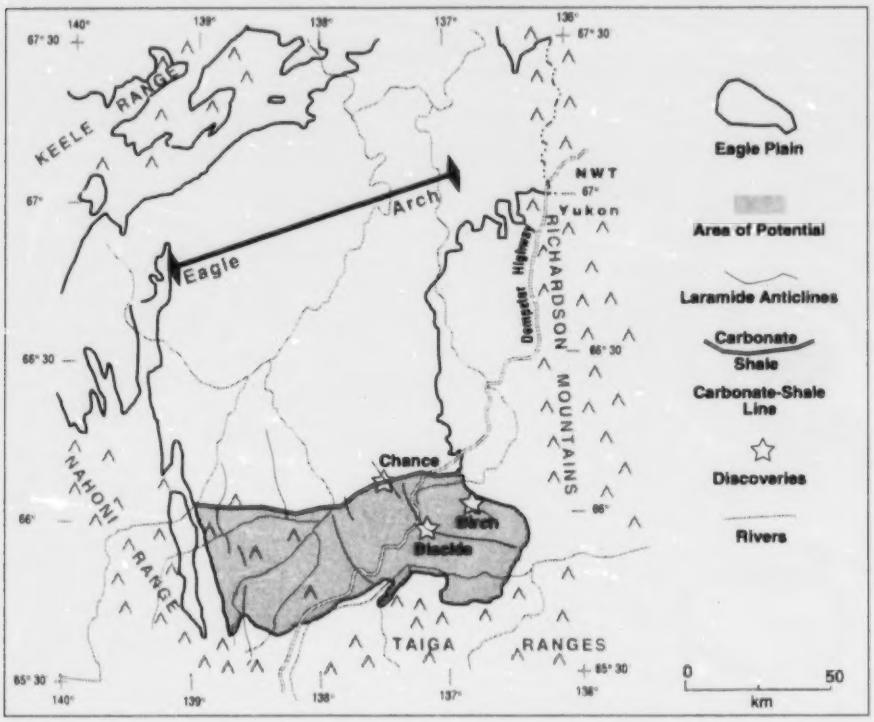
# ETTRAIN CARBONATE

## IMMATURE GAS PLAY

### *Reservoir description*

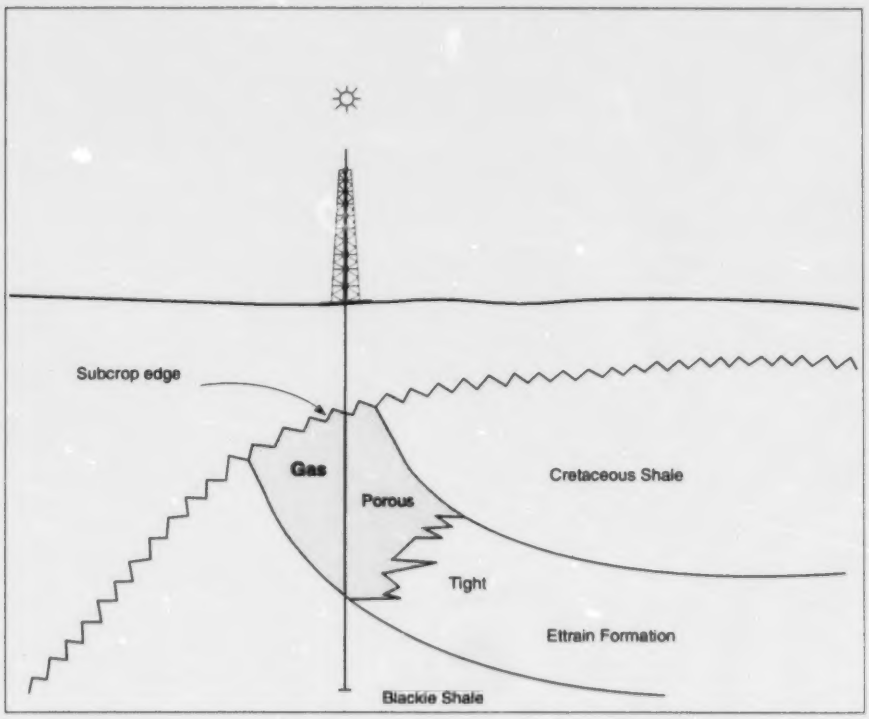
The Ettrain carbonate play results from the stratigraphic pinchout of porous carbonates trapped against the subcrop edge or against non-porous carbonates within the unit. Structures would enhance the stratigraphic plays but are not necessary for the play.

The Ettrain carbonate unit is described as a light-brown skeletal or micritic limestone with interbeds of dark-grey chert and dolomite. Thickness of this unit is variable, averaging about 90 m, with a maximum thickness of more than 240 m.



### *Undiscovered resources*

Nine wells have been drilled penetrating the Ettrain Formation. However, there have been no hydrocarbon discoveries or any shows reported in this zone. One show previously reported from this play is actually in Jungle Creek Sandstone. The area for potential discoveries is limited by the subcrop edge of the unit and by the number of penetrations by the unsuccessful wells. Due to the limited amount of potential, this play should probably be a secondary target only. It is considered to be a gas play.



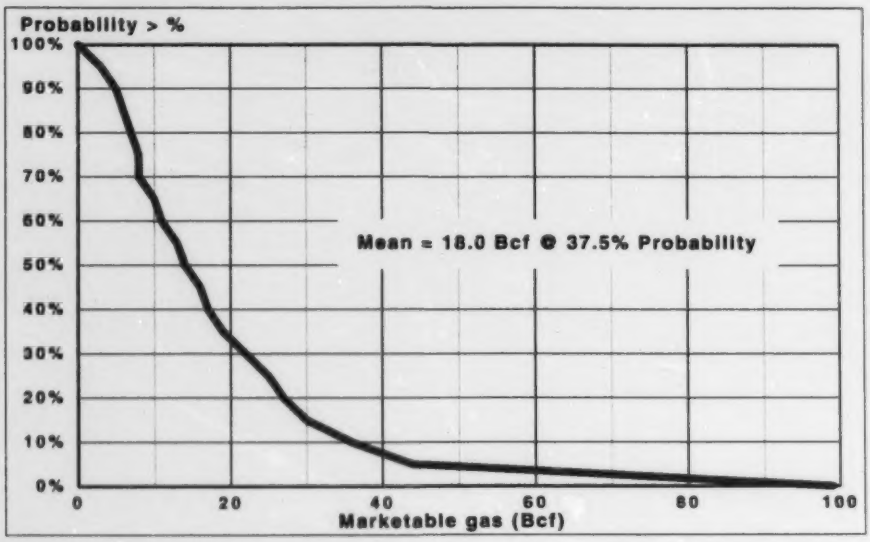
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 0.7500 | 0.9000 | 1.0000 | 0.883 |
| Tested play area (MM acres) | 0.056 | 0.056 | 0.056 | 0.056 |
| Untested play area (MM acres) | 0.694 | 0.844 | 0.944 | 0.827 |
| Fraction of total play area in trap | 0.030 | 0.100 | 0.300 | 0.143 |
| Fraction of untested play area filled (areally) | 0.300 | 0.600 | 0.800 | 0.567 |
| Potential hydrocarbon area (MM acres) | | | | 0.067 |
| Porosity | 0.030 | 0.090 | 0.150 | 0.090 |
| Hydrocarbon saturation | 0.550 | 0.600 | 0.700 | 0.617 |
| Oil recovery factor | 0.100 | 0.200 | 0.300 | 0.200 |
| Gas recovery factor | 0.650 | 0.750 | 0.850 | 0.750 |
| Average net pay (ft.) | 5.0 | 20.0 | 50.0 | 25.0 |
| Probability of hydrocarbons | 0.020 | 0.080 | 0.150 | 0.083 |
| Fraction of pore volume oil bearing | 0.000 | 0.000 | 0.000 | 0.000 |
| Potential oil area (MM acres) | | | | 0.000 |
| Potential gas area (MM acres) | | | | 0.006 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.238 | 0.250 | 0.263 | 0.250 |
| Formation volume factor (FVF) | 1.135 | 1.143 | 1.150 | 1.143 |
| Gas compressibility factor 'Z' | 0.784 | 0.800 | 0.816 | 0.800 |
| Gas volume factor (GVF) | | | | 0.075 |
| Oil in place (bbls/acre-foot) | | | | 376.9 |
| Oil recovery (bbls/acre-foot) | | | | 75.4 |
| Gas in place (MMcf/acre-foot) | | | | 180.4 |
| Raw gas recovery (MMcf/acre-foot) | | | | 135.3 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 127.2 |
| Liquid yield (bbls/MMcf) | 6.0 | 8.0 | 10.0 | 8.0 |
| $H_2S$ content | 0.0 | 0.0 | 0.0 | 0.000 |
| $CO_2$ content | 0.005 | 0.010 | 0.020 | 0.012 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.940 | | |

*Total for play*

| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 0.00 | | 25.26 | 25.26 | | 4.21 | |
| **Recoverable** | 0.00 | 0.00 | 18.95 | 18.95 | 0.15 | 3.31 | 17.81 |
| **Sulphur (MMlt)** | | 0.00 | | | | | |

Oil depth: 2,500 ft.; gas depth: 2,500 ft.; gas pressure: 900 psi; gas reservoir temperature: 75°F




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 3 |
| 90% | 5 |
| 85% | 6 |
| 80% | 7 |
| 75% | 8 |
| 70% | 8 |
| 65% | 10 |
| 60% | 11 |
| 55% | 13 |
| 50% | 14 |
| 45% | 16 |
| 40% | 17 |
| 35% | 19 |
| 30% | 22 |
| 25% | 25 |
| 20% | 27 |
| 15% | 30 |
| 10% | 36 |
| 5% | 44 |
| 0% | 99 |

## Devonian

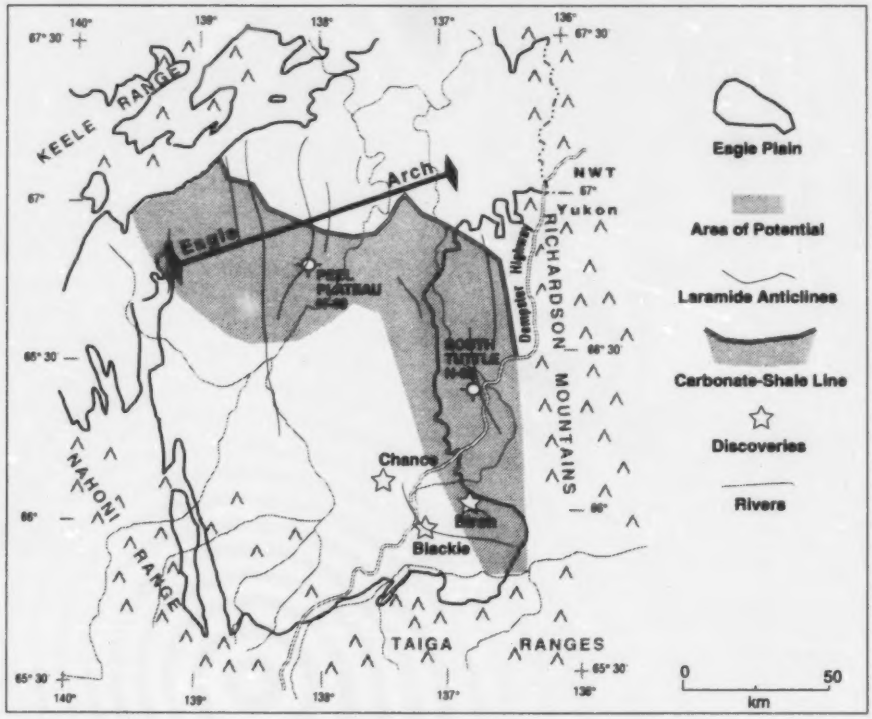
## OGILVIE CARBONATE STRATIGRAPHIC

# IMMATURE GAS PLAY

### *Reservoir description*

The Ogilvie carbonate stratigraphic facies change traps exist where porous carbonates are present against tight basinal shale or against non-porous carbonate within the formation. For this play, the majority of potential is expected in the upper limestone as the lower dolomite is not present at the carbonate-shale edge. It is only present in the back-bank position. As a result, there is also potential for gas at the dolomite/limestone interface.

The lower Ogilvie dolomite is described as brown to buff, finely crystalline to sucrosic dolomite with vuggy and intercyrstalline porosity. The upper Ogilvie limestone is described as medium-brown to grey, fine-grained, thin-bedded to massive limestone with beds of coarse-grained encrinite. The unit is very thick – more than 1,220 m within the basin.



### *Discovered resources*

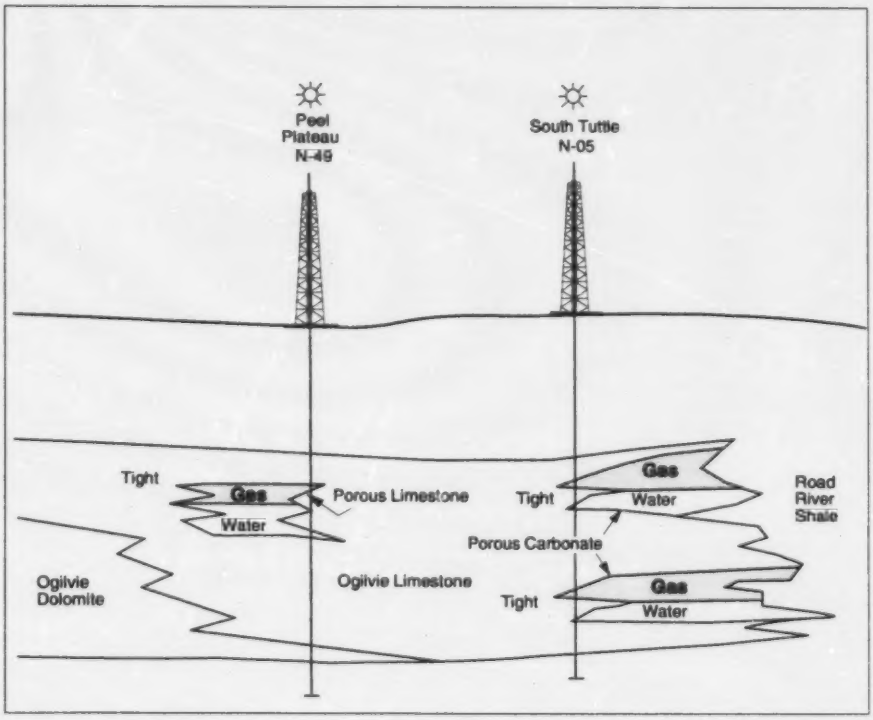
One gas show has been recorded in the South Tuttle N-05 well. This flowed gas at a maximum rate of 28 $10^3m^3/d$ from the lower dolomite. However, the flow rate declined rapidly. Gassy mud from the Ogilvie limestone was recovered in the Peel Plateau N-49 well.

### *Potential resources*

The area of potential resources is restricted to a region shelfward of the carbonate-shale facies change on the northeast side. The play extends east of the basin edge into the Richardson Trough. This is considered to be a gas play due to the maturation level in the source rocks.

### *Reservoir parameters*

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| South Tuttle | gas | 0 | 4.3 | 11 | 70 | 0 | 0 (0) |
| Peel Plateau | gas | 0 | 3 | ? | ? | 0 | 0 (0) |



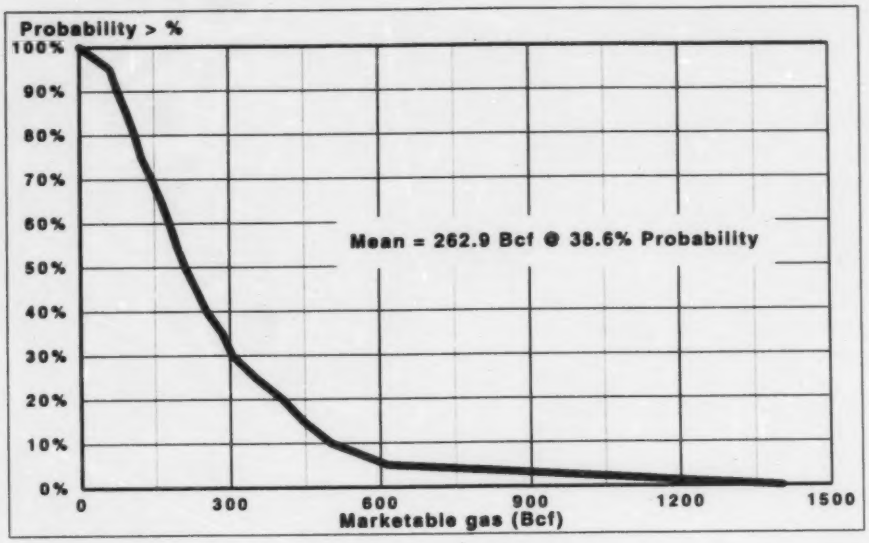
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 0.8000 | 1.5000 | 2.0000 | 1.433 |
| Tested play area (MM acres) | 0.450 | 0.450 | 0.450 | 0.450 |
| Untested play area (MM acres) | 0.350 | 1.050 | 1.550 | 0.983 |
| Fraction of total play area in trap | 0.090 | 0.200 | 0.330 | 0.207 |
| Fraction of untested play area filled (areally) | 0.200 | 0.500 | 0.700 | 0.467 |
| Potential hydrocarbon area (MM acres) | | | | 0.095 |
| Porosity | 0.050 | 0.110 | 0.150 | 0.103 |
| Hydrocarbon saturation | 0.600 | 0.700 | 0.800 | 0.700 |
| Oil recovery factor | 0.100 | 0.200 | 0.300 | 0.200 |
| Gas recovery factor | 0.600 | 0.700 | 0.800 | 0.700 |
| Average net pay (ft.) | 10.0 | 25.0 | 100.0 | 45.0 |
| Probability of hydrocarbons | 0.050 | 0.100 | 0.200 | 0.117 |
| Fraction of pore volume oil bearing | 0.000 | 0.000 | 0.000 | 0.000 |
| Potential oil area (MM acres) | | | | 0.000 |
| Potential gas area (MM acres) | | | | 0.011 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.589 | 0.620 | 0.651 | 0.620 |
| Formation volume factor (FVF) | 1.336 | 1.353 | 1.371 | 1.353 |
| Gas compressibility factor 'Z' | 0.882 | 0.900 | 0.918 | 0.900 |
| Gas volume factor (GVF) | | | | 0.265 |
| Oil in place (bbls/acre-foot) | | | | 414.6 |
| Oil recovery (bbls/acre-foot) | | | | 82.9 |
| Gas in place (MMcf/acre-foot) | | | | 835.4 |
| Raw gas recovery (MMcf/acre-foot) | | | | 584.8 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 538.0 |
| Liquid yield (bbls/MMcf) | 7.0 | 11.0 | 15.0 | 11.0 |
| $H_2S$ content | 0.001 | 0.010 | 0.020 | 0.010 |
| $CO_2$ content | 0.002 | 0.020 | 0.050 | 0.024 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.920 | | |

*Total for play*

| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| In place | 0.00 | | 415.94 | 415.94 | | 69.32 | |
| Recoverable | 0.00 | 0.00 | 291.16 | 291.16 | 3.20 | 51.73 | 267.86 |
| Sulphur (MMlt) | | 0.11 | | | | | |

Oil depth: 6,200 ft.; gas depth: 6,200 ft.; gas pressure: 4,000 psi; gas reservoir temperature: 135°F




| *Percentile values* | |
|---|---|
| 100% | 0 |
| 95% | 61 |
| 90% | 77 |
| 85% | 95 |
| 80% | 111 |
| 75% | 124 |
| 70% | 145 |
| 65% | 164 |
| 60% | 180 |
| 55% | 194 |
| 50% | 211 |
| 45% | 233 |
| 40% | 254 |
| 35% | 285 |
| 30% | 305 |
| 25% | 351 |
| 20% | 406 |
| 15% | 447 |
| 10% | 502 |
| 5% | 614 |
| 0% | 1,402 |

## Devonian

## OGILVIE CARBONATE STRUCTURAL

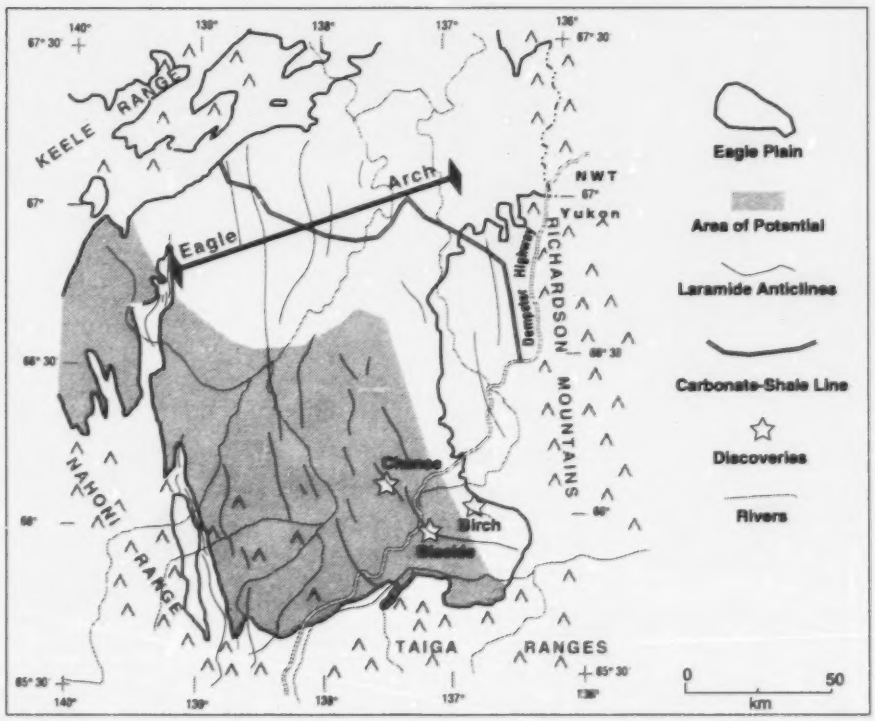
# IMMATURE GAS PLAY

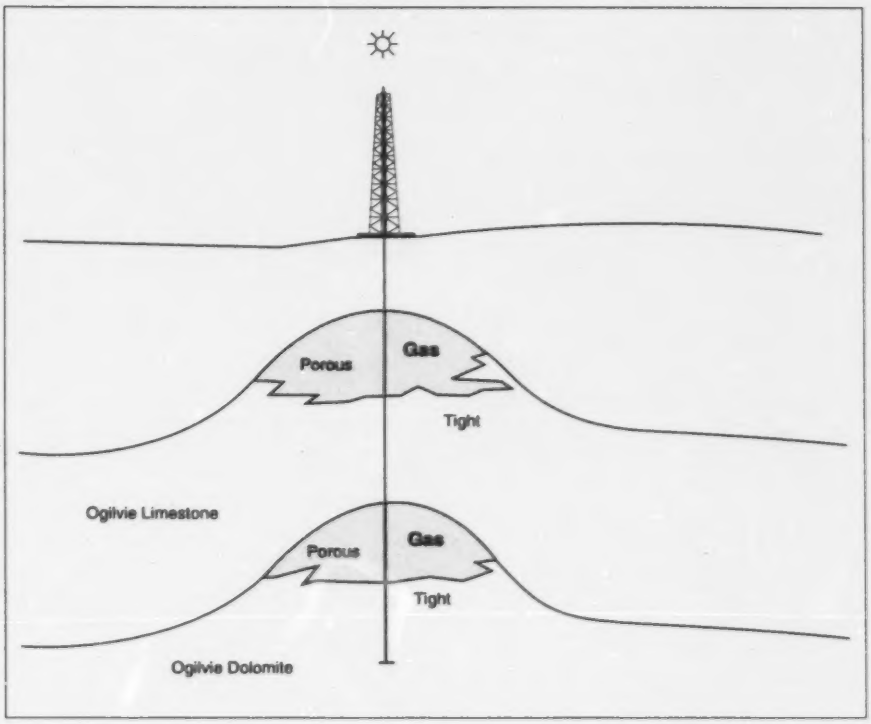
### *Reservoir description*

Antiforms have been observed on seismic sections in the Lower Devonian Ogilvie Formation in the sub-surface. These structures are independent of the Laramide anticlines observed on the present day basin surface.

### *Potential resources*

At least one well has penetrated a Devonian antiform structure in the South Eagle Sub-basin, but without success. There have been several structures mapped with available seismic sections. The area of potential is on the west side of the plain, shelfward of the area of potential for the Ogilvie carbonate-shale facies change play. This is expected to be a gas play due to the maturation levels in the source rocks.




Porous
Gas
Tight
Ogilvie Limestone
Porous
Gas
Tight
Ogilvie Dolomite

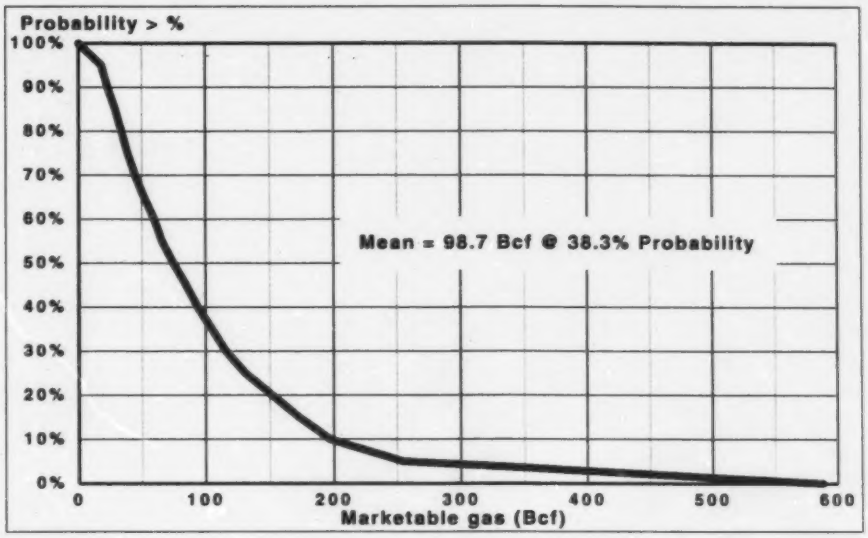
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 1.5000 | 2.3000 | 3.0000 | 2.267 |
| Tested play area (MM acres) | 0.020 | 0.020 | 0.020 | 0.020 |
| Untested play area (MM acres) | 1.480 | 2.280 | 2.980 | 2.247 |
| Fraction of total play area in trap | 0.050 | 0.100 | 0.150 | 0.100 |
| Fraction of untested play area filled (areally) | 0.020 | 0.150 | 0.300 | 0.157 |
| Potential hydrocarbon area (MM acres) | | | | 0.035 |
| Porosity | 0.050 | 0.110 | 0.150 | 0.103 |
| Hydrocarbon saturation | 0.600 | 0.700 | 0.800 | 0.700 |
| Oil recovery factor | 0.100 | 0.200 | 0.300 | 0.200 |
| Gas recovery factor | 0.600 | 0.700 | 0.800 | 0.700 |
| Average net pay (ft.) | 10.0 | 25.0 | 100.0 | 45.0 |
| Probability of hydrocarbons | 0.010 | 0.100 | 0.200 | 0.103 |
| Fraction of pore volume oil bearing | 0.000 | 0.000 | 0.000 | 0.000 |
| Potential oil area (MM acres) | | | | 0.000 |
| Potential gas area (MM acres) | | | | 0.004 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.589 | 0.620 | 0.651 | 0.620 |
| Formation volume factor (FVF) | 1.336 | 1.353 | 1.371 | 1.353 |
| Gas compressibility factor 'Z' | 0.882 | 0.900 | 0.918 | 0.900 |
| Gas volume factor (GVF) | | | | 0.297 |
| Oil in place (bbls/acre-foot) | | | | 414.6 |
| Oil recovery (bbls/acre-foot) | | | | 82.9 |
| Gas in place (MMcf/acre-foot) | | | | 935.1 |
| Raw gas recovery (MMcf/acre-foot) | | | | 654.6 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 602.2 |
| Liquid yield (bbls/MMcf) | 7.0 | 11.0 | 15.0 | 11.0 |
| $H_2S$ content | 0.001 | 0.010 | 0.020 | 0.010 |
| $CO_2$ content | 0.002 | 0.020 | 0.050 | 0.024 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.920 | | |

*Total for play*

| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 0.00 | | 153.05 | 153.05 | | 25.51 | |
| **Recoverable** | 0.00 | 0.00 | 107.13 | 107.13 | 1.18 | 19.03 | 98.56 |
| **Sulphur (MMt)** | | 0.04 | | | | | |

Oil depth: 6,200 ft.; gas depth: 6,300 ft.; gas pressure: 4,500 psi; gas reservoir temperature: 138°F




| *Percentile values* | |
|---|---|
| 100% | 0 |
| 95% | 18 |
| 90% | 23 |
| 85% | 29 |
| 80% | 34 |
| 75% | 39 |
| 70% | 45 |
| 65% | 52 |
| 60% | 60 |
| 55% | 66 |
| 50% | 75 |
| 45% | 85 |
| 40% | 94 |
| 35% | 105 |
| 30% | 116 |
| 25% | 131 |
| 20% | 152 |
| 15% | 173 |
| 10% | 197 |
| 5% | 255 |
| 0% | 588 |

## Ordovician-Silurian

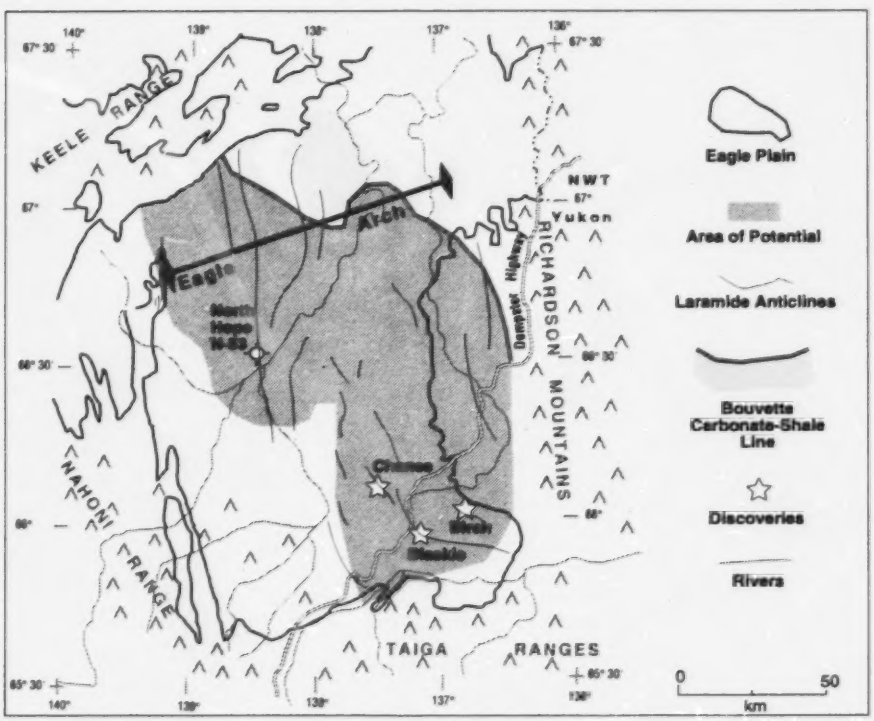
## BOUVETTE STRATIGRAPHIC

# IMMATURE GAS PLAY

### *Reservoir description*

The Bouvette carbonate-shale facies transition play is similar to the Ogilvie carbonate shale out to Road River basinal shale in the Richardson Trough. Porous carbonate of Cambrian to Silurian age is trapped against tight basinal Road River shale or against non-porous carbonate within the formation.

The Bouvette formation is a generalized description for the succession of Lower Paleozoic carbonates. In this area, the succession consists of a thin upper cherty limestone and dolomite unit, which caps a thicker section of light-coloured, medium to coarsely crystalline dolomite, grey-coloured microcrystalline dolomite and interbedded orthoquartzite and shale. This very thick succession of carbonate reaches a maximum thickness of 2,040 m within the basin.



### *Discovered resources*

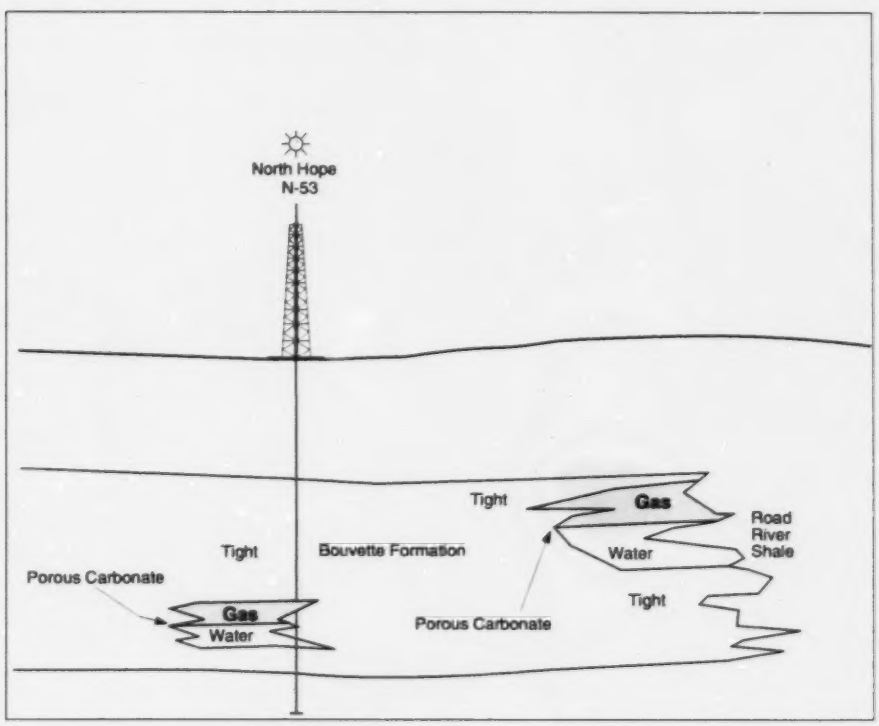
The North Hope N-53 well, drilled in 1970, recovered gas-cut mud and gas-cut water cut mud from Bouvette carbonate. No other shows have been reported from this zone.

### *Potential resources*

The area of potential resources is limited to a region south of the carbonate-shale facies change on the northeast side of the basin. This play also extends east of the basin into the Richardson Trough and is also considered to be a gas play, due to the maturation levels in the source rocks.

### *Reservoir parameters*

| Field | Resources | Area (ha.) | Net Pay (m) | Porosity (%) | Hydrocarbon saturation (%) | Recovery factor (%) | Initial marketable gas $10^6m^3$ (Bcf) |
|---|---|---|---|---|---|---|---|
| North Hope | gas | 0 | 6 | 9 | 60 | 0 | 0 (0) |



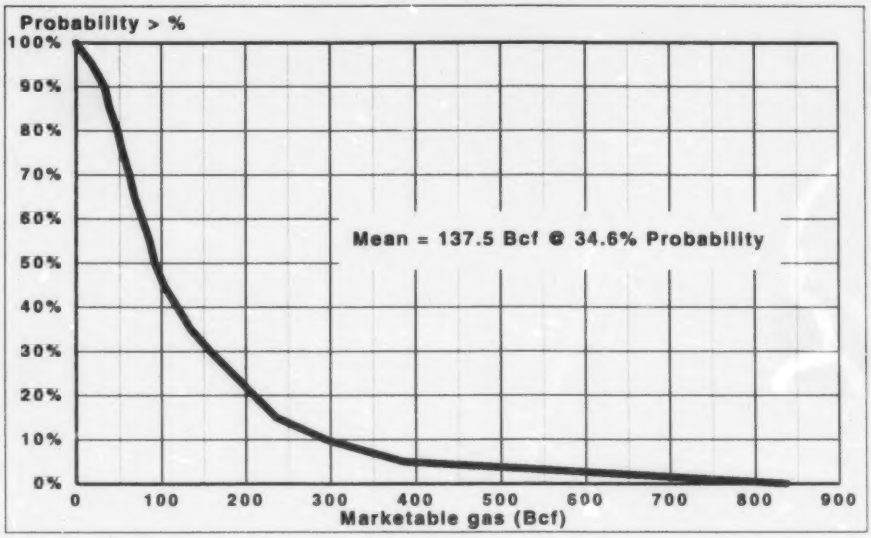
*Estimate of potential petroleum resources*

| | Minimum | Most likely | Maximum | Mean |
|---|---|---|---|---|
| Total play area (MM acres) | 1.5000 | 2.5000 | 3.0000 | 2.333 |
| Tested play area (MM acres) | 0.340 | 0.340 | 0.340 | 0.340 |
| Untested play area (MM acres) | 1.160 | 2.160 | 2.660 | 1.993 |
| Fraction of total play area in trap | 0.020 | 0.100 | 0.250 | 0.123 |
| Fraction of untested play area filled (areally) | 0.100 | 0.300 | 0.500 | 0.300 |
| Potential hydrocarbon area (MM acres) | | | | 0.074 |
| Porosity | 0.030 | 0.090 | 0.150 | 0.090 |
| Hydrocarbon saturation | 0.550 | 0.600 | 0.700 | 0.617 |
| Oil recovery factor | 0.100 | 0.200 | 0.300 | 0.200 |
| Gas recovery factor | 0.650 | 0.750 | 0.850 | 0.750 |
| Average net pay (ft.) | 5.0 | 20.0 | 100.0 | 41.7 |
| Probability of hydrocarbons | 0.020 | 0.100 | 0.200 | 0.107 |
| Fraction of pore volume oil bearing | 0.000 | 0.000 | 0.000 | 0.000 |
| Potential oil area (MM acres) | | | | 0.000 |
| Potential gas area (MM acres) | | | | 0.008 |
| Gas oil ratio (GOR) (MMcf/bbls) | 0.950 | 1.000 | 1.050 | 1.000 |
| Formation volume factor (FVF) | 1.542 | 1.570 | 1.599 | 1.570 |
| Gas compressibility factor 'Z' | 0.882 | 0.900 | 0.918 | 0.900 |
| Gas volume factor (GVF) | | | | 0.283 |
| Oil in place (bbls/acre-foot) | | | | 274.2 |
| Oil recovery (bbls/acre-foot) | | | | 54.8 |
| Gas in place (MMcf/acre-foot) | | | | 683.1 |
| Raw gas recovery (MMcf/acre-foot) | | | | 512.3 |
| Marketable gas recovery (MMcf/acre-foot) | | | | 429.8 |
| Liquid yield (bbls/MMcf) | 0.1 | 0.2 | 0.2 | 0.2 |
| $H_2S$ content | 0.0 | 0.0 | 0.0 | 0.000 |
| $CO_2$ content | 0.070 | 0.111 | 0.150 | 0.110 |
| Gas to BOE conversion factor (MMcf/BOE) | | 6.000 | | |
| Surface loss (fuel gas, etc.) | | 0.050 | | |
| Marketable gas (fraction of raw) | | 0.839 | | |

*Total for play*

| | Oil (MMb) | Solution gas (Bcf) | Non associated gas (Bcf) | Total gas (BcF) | Liquids (MMb) | Barrels of oil equivalent (MMBOE) | Marketable gas (Bcf) |
|---|---|---|---|---|---|---|---|
| **In place** | 0.00 | | 223.92 | 223.92 | | 37.32 | |
| **Recoverable** | 0.00 | 0.00 | 167.94 | 167.94 | 0.03 | 28.02 | 140.90 |
| **Sulphur (MMlt)** | | 0.00 | | | | | |

Oil depth: 10,000 ft.; gas depth:10,900 ft.; gas pressure: 4,700 psi; gas reservoir temperature: 196°F




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 19 |
| 90% | 33 |
| 85% | 39 |
| 80% | 48 |
| 75% | 54 |
| 70% | 62 |
| 65% | 68 |
| 60% | 77 |
| 55% | 86 |
| 50% | 92 |
| 45% | 103 |
| 40% | 119 |
| 35% | 135 |
| 30% | 158 |
| 25% | 184 |
| 20% | 210 |
| 15% | 236 |
| 10% | 295 |
| 5% | 385 |
| 0% | 837 |

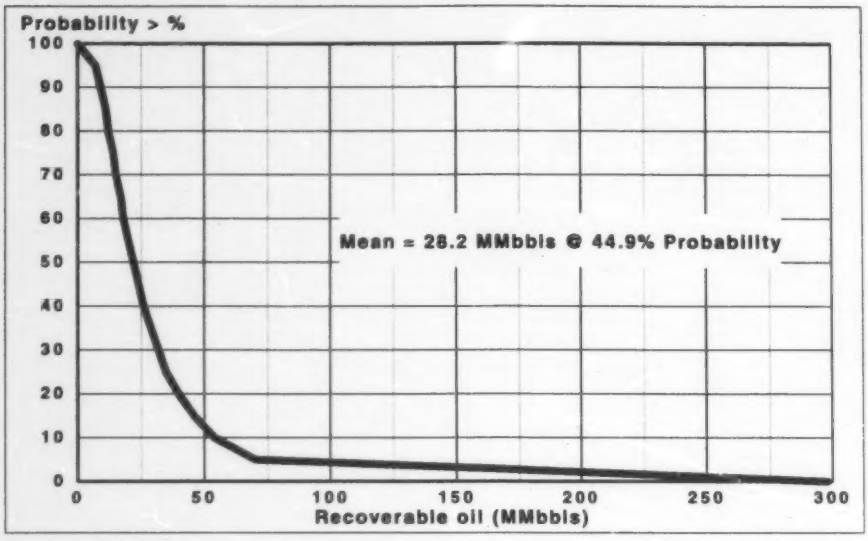
# DISCUSSION OF RESULTS

The probability charts for the Eagle Plain study area, showing the total potential marketable gas and the total undiscovered recoverable oil, are on the following pages; values are listed in Table 3. For gas, the range is from 9.0 billion $m^3$ (316 Bcf) at 95% probability to 63.6 billion $m^3$ (2.24 Tcf) at 5% probability with a mean of 28.5 billion $m^3$ (1.01 Tcf) at a probability of 45%. For oil, the range is from 1.11 million $m^3$ (7 MMBbls) at 95% probability to 11.13 million $m^3$ (70 MMBbls) at 5% probability, with a mean of 4.5 million $m^3$ (28.2 MMBbls) at 45% probability. In addition, the program generates values for by-products. At the mean gas value, there are estimated to be 2.4 million $m^3$ (14.9 MMBbls) of natural gas liquids.

On a play basis, the Upper Carboniferous Hart River Formation members, the Chance Member sandstone and Canoe River Member limestone contain the vast majority of the oil potential with over 99% at the mean estimate. For gas, the distribution is more diverse. In total, carbonate reservoirs are expected to contain over 55% of the gas. The Devonian carbonates, namely the Ogilvie limestone and dolomite, are expected to contain about 36% of the total gas, with the older Bouvette Formation carbonate containing an additional 14% and the Canoe River Member an additional 6%. For clastic reservoirs, the distribution is: 23% of the total gas in the Chance Sandstone, 8% of the total in the Tuttle Formation and 10% of the total in the Cretaceous Sandstone.

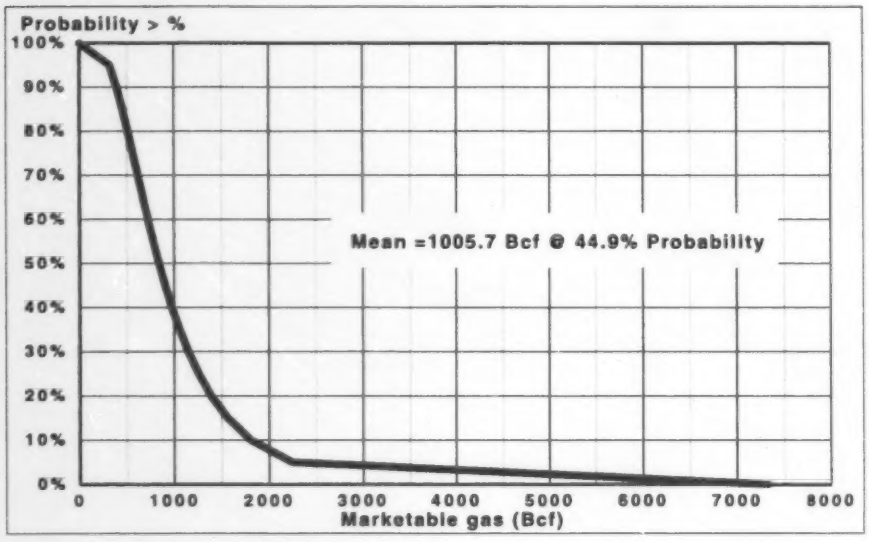
***Table 3.*** *Eagle Plain Potential Resources*

| | | Recoverable Oil MMbbls | | Marketable Gas Bcf | | Liquid By-Products MMbbls | |
|---|---|---|---|---|---|---|---|
| **Age** | **Play Name** | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** |
| Late Cretaceous | Fishing Branch Sandstone | 0.00 | 0.00 | 54.28 | 30.64 | 0.30 | 0.17 |
| Permian | Jungle Creek Sandstone | 0.12 | 0.08 | 30.01 | 15.00 | 0.02 | 0.00 |
| Carboniferous | Ettrain Carbonate | 0.00 | 0.00 | 18.05 | 14.65 | 0.15 | 0.13 |
| Carboniferous | Chance Sandstone Structural | 1.29 | 0.73 | 90.82 | 37.57 | 1.93 | 0.82 |
| Carboniferous | Chance Sandstone Unconformity | 13.38 | 8.56 | 79.63 | 39.10 | 2.86 | 1.43 |
| Carboniferous | Chance Sandstone Stratigraphic | 12.37 | 7.07 | 56.16 | 28.81 | 1.53 | 0.81 |
| Carboniferous | Canoe River Member Limestone | 1.02 | 0.97 | 55.75 | 47.17 | 2.21 | 1.92 |
| Carboniferous | Tuttle Formation | 0.00 | 0.00 | 75.73 | 57.34 | 1.29 | 0.91 |
| Devonian | Ogilvie Carbonate | 0.00 | 0.00 | 262.87 | 184.30 | 3.14 | 2.30 |
| Devonian | Ogilvie Structural | 0.00 | 0.00 | 98.74 | 84.57 | 1.17 | 0.99 |
| Cretaceous | Triangle Zone Structural | 0.00 | 0.00 | 46.51 | 33.61 | 0.26 | 0.19 |
| Ordovician | Bouvette Stratigraphic | 0.00 | 0.00 | 137.50 | 129.22 | 0.03 | 0.02 |
| **Totals** | | **28.17** | | **1006.0** | | **14.90** | |
| | Total Chance Sandstone | 27.04 | | 226.61 | | 6.33 | |
| | Total Carboniferous | 28.06 | | 376.13 | | 9.98 | |
| | Total Devonian | | | 361.61 | | 4.31 | |
| | Total Lower Paleozoic | | | 545.62 | | 4.60 | |
| | Total Cretaceous | | | 100.79 | | 0.56 | |




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 7 |
| 90% | 9 |
| 85% | 11 |
| 80% | 12 |
| 75% | 14 |
| 70% | 15 |
| 65% | 17 |
| 60% | 18 |
| 55% | 20 |
| 50% | 22 |
| 45% | 24 |
| 40% | 26 |
| 35% | 29 |
| 30% | 32 |
| 25% | 35 |
| 20% | 40 |
| 15% | 46 |
| 10% | 54 |
| 5% | 70 |
| 0% | 298 |




*Percentile values*

| | |
|---|---|
| 100% | 0 |
| 95% | 316 |
| 90% | 392 |
| 85% | 454 |
| 80% | 510 |
| 75% | 563 |
| 70% | 616 |
| 65% | 669 |
| 60% | 724 |
| 55% | 781 |
| 50% | 842 |
| 45% | 908 |
| 40% | 979 |
| 35% | 1,059 |
| 30% | 1,151 |
| 25% | 1,259 |
| 20% | 1,390 |
| 15% | 1,562 |
| 10% | 1,808 |
| 5% | 2,245 |
| 0% | 7,330 |

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# CHANCE STRUCTURE

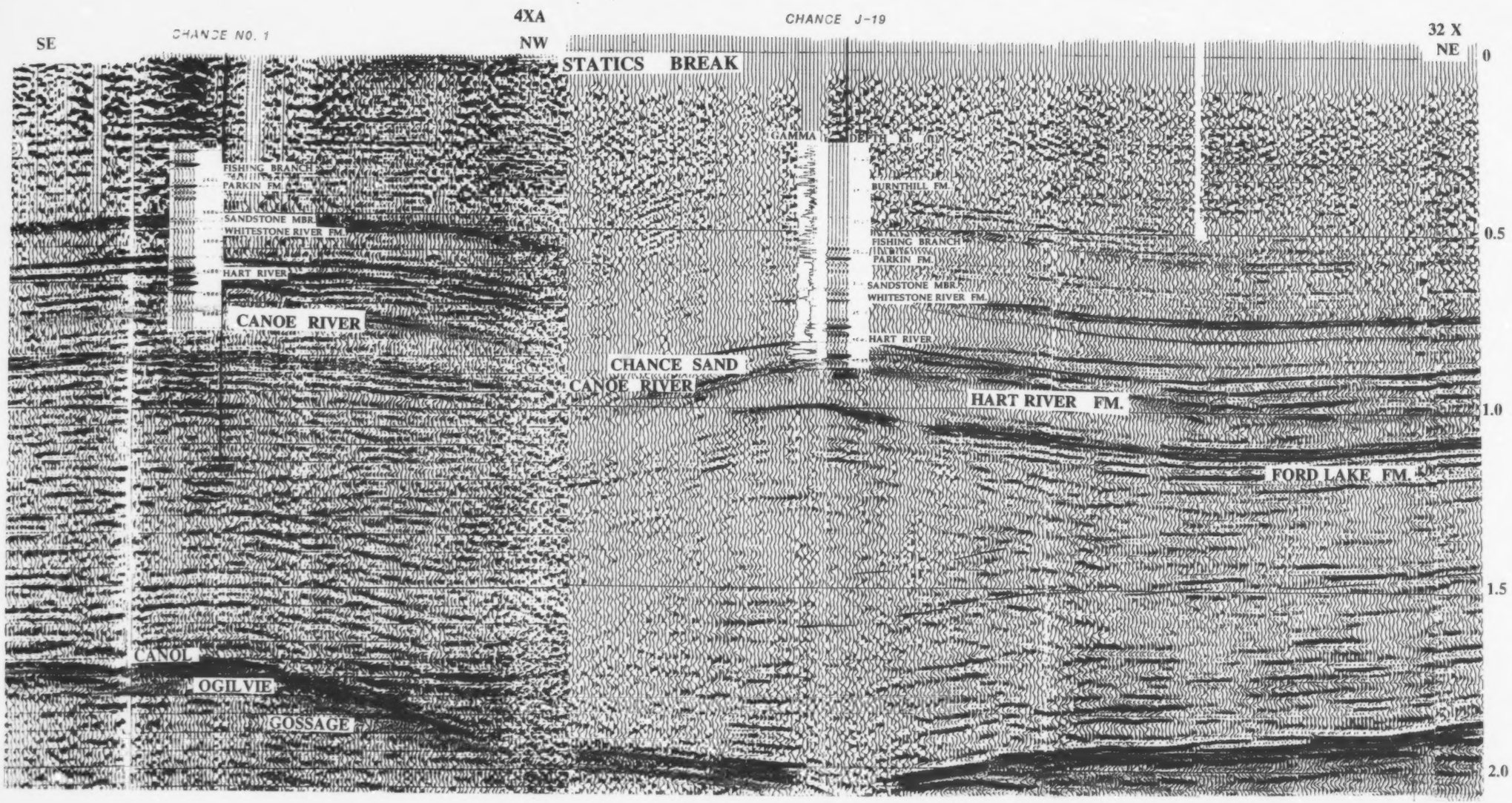


Figure 7. Seismic line 4XA and 32X Chevron 1971
Interpretation NEB

# PALEOZOIC SUBCROP EDGE

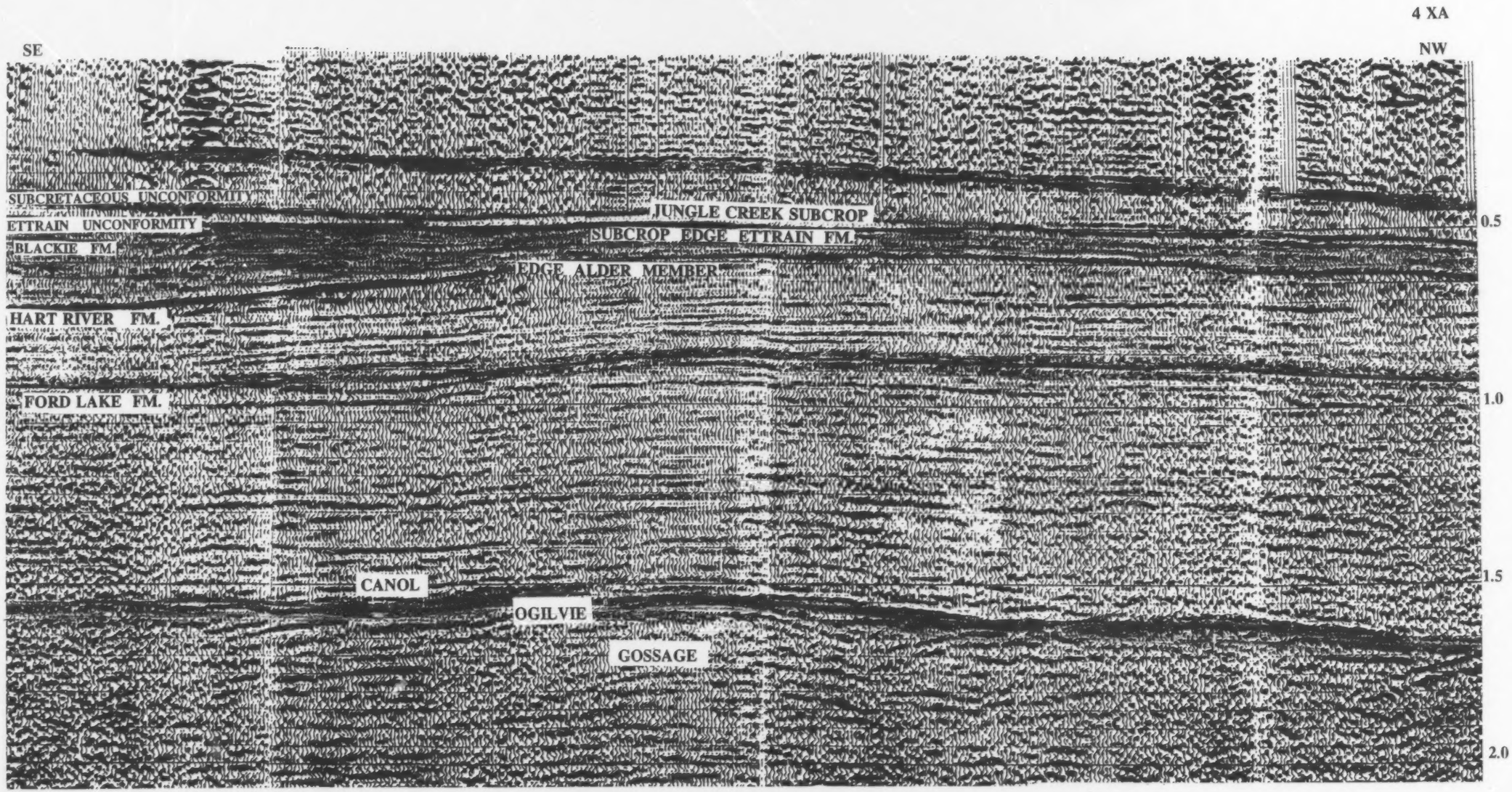


**Figure 8.** Seismic line 4XA. Chevron 1971
Interpretation NEB

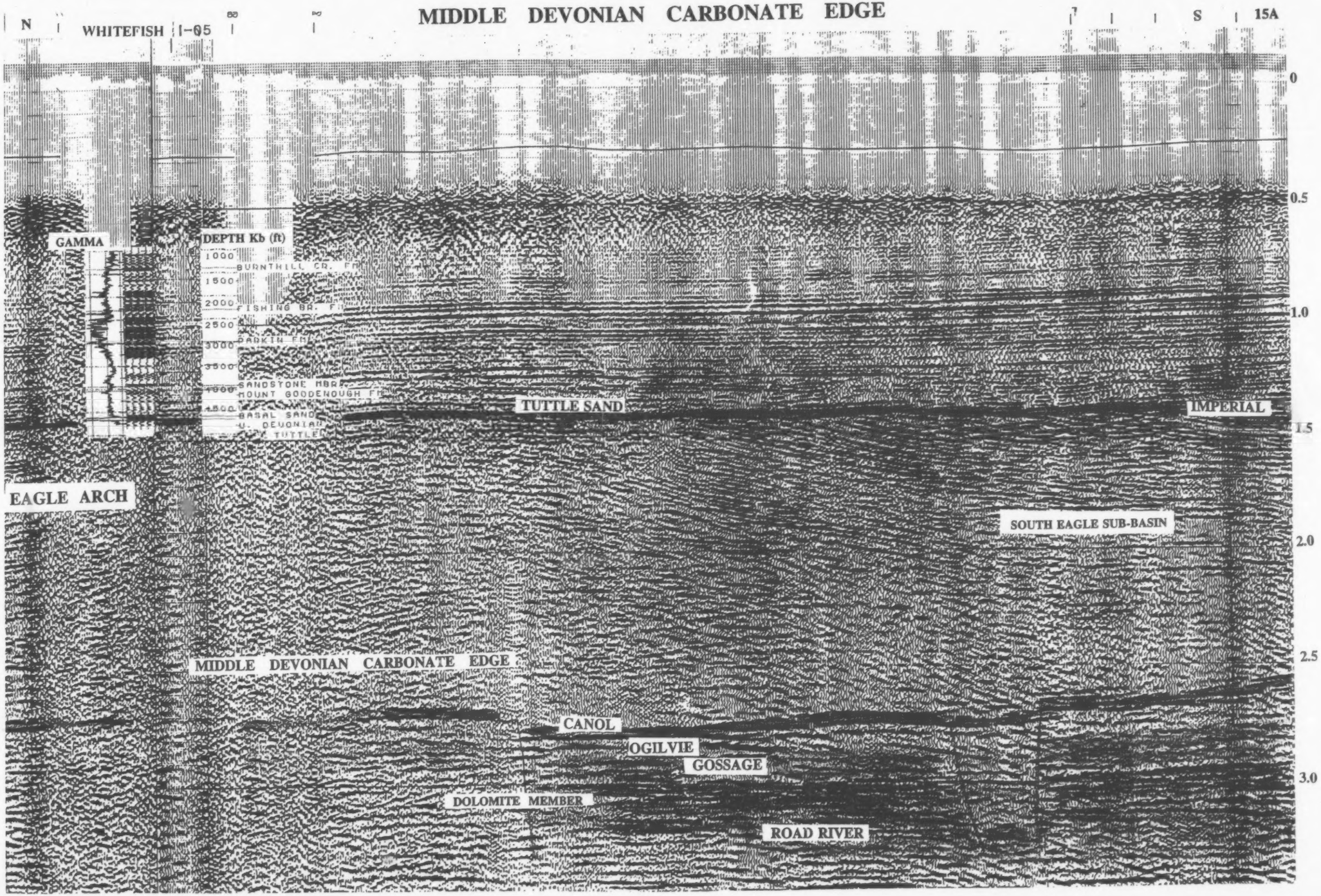


**Figure 9. Seismic line 15A. Chevron 1971 Interpretation NEB**

## NORTH EAGLE PLAINS

SE NW

39X

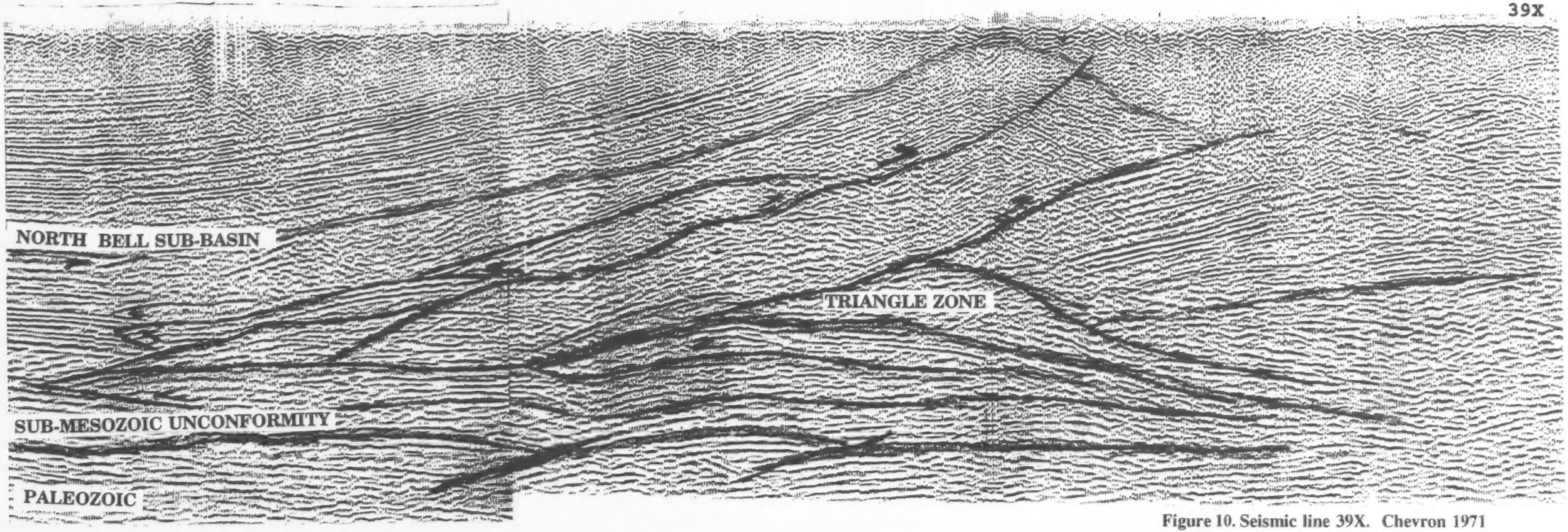


Figure 10. Seismic line 39X. Chevron 1971
Interpretation NEB